TEST VERSUS PREDICTIONS FOR ROTORDYNAMIC COEFFICIENTS AND LEAKAGE RATES OF HOLE-PATTERN GAS SEALS AT TWO CLEARANCES IN CHOKED AND UNCHOKED CONDITIONS

A Thesis

by

JONATHAN LEIGH WADE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2004

Major Subject: Mechanical Engineering

TEST VERSUS PREDICTIONS FOR ROTORDYNAMIC COEFFICIENTS AND LEAKAGE RATES OF HOLE-PATTERN GAS SEALS AT TWO CLEARANCES IN CHOKED AND UNCHOKED CONDITIONS

A Thesis

by

JONATHAN LEIGH WADE

Submitted to Texas A&M University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Approved as to style and content by:

Dara W. Childs (Chair of Committee)	John M. Vance (Member)
Othon K. Rediniotis (Member)	Dennis L. O'Neal (Head of Department)

May 2004

Major Subject: Mechanical Engineering

ABSTRACT

Test Versus Predictions for Rotordynamic Coefficients and Leakage Rates of Hole-Pattern Gas Seals at Two Clearances in Choked and Unchoked Conditions.

(May 2004)

Jonathan Leigh Wade, B.S., Texas A&M University

Chair of Advisory Committee: Dr. Dara W. Childs

This thesis documents the results of high pressure testing of hole-pattern annular gas seals conducted at the Texas A&M University's Turbomachinery Laboratory. The testing conditions were aimed at determining the test seals sensitivity to pressure ratio, inlet fluid preswirl, rotor speed, and rotor to seal clearance.

The rotordynamic coefficients showed only small changes resulting from the different pressure ratios tested. Only the damping terms at the lower frequencies showed some influence. One other notable result from the testing of different pressure ratios is that the seals were tested in a choked flow condition, and there was not a significant change in the seal behavior when the seals transitioned to the choked condition.

The inlet fluid preswirl only had a notable effect on the cross-coupled stiffness in the larger clearance tests. These results lead to the conclusion that a swirl brake could have some rotordynamic value, but only if the seals have sufficiently large clearance. Conversely this also means that if hole-pattern seals are being implemented with a small clearance, then a swirl brake would not be an effective way to improve the rotordynamic stability of the system.

The only significant effect that the rotor speeds had on the rotordynamic coefficients were that the cross-coupled coefficients increased as the rotor speed increased. This is the expected result because as the rotor speed increases there is a greater shear force on the gas as it passes through the seal resulting in more fluid circumferential velocity, which results in stronger cross-coupled coefficients.

The changes in clearance resulted in drastic changes in the magnitude of the coefficients. The smaller clearance yielded much higher coefficients than the larger clearance.

All of the rotordynamic coefficients were predicted well by ISOTSEAL. The code was found to do a good job predicting the seal leakage as well. This gives more credence to the coefficients and leakage that ISOTSEAL predicts.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to Dr. Childs for his guidance and advice during my time at the Turbomachinery Laboratory. Thank you for helping me continue my education.

I would like to thank Arthur Picardo for his invaluable friendship and instruction about rotordynamics and the testing process. I would like to thank all of the students at the Turbo Lab for their friendship and camaraderie.

TABLE OF CONTENTS

Page

Page

LIST OF FIGURES

FIGURE Page

FIGURE Page

FIGURE Page

LIST OF TABLES

TABLE Page

TABLE Page

NOMENCLATURE

A_{ij}	-	Stator acceleration	[L/T^2]
C_r	-	Radial Clearance	[L]
C	-	Direct damping	[FT/L]
c	-	Cross-coupled damping	[FT/L]
C_{ij}	-	Damping Coefficient	[FT/L]
C_{eff}	-	Effective Damping	[FT/L]
D_s	-	Seal Diameter	[L]
D_r	-	Rotor Diameter	[L]
D_{ij}	-	Relative Displacement	[L]
F_s	-	Seal reaction forces	[F]
F_{ij}	-	Force	[F]
g	-	Acceleration due to gravity	[L/T^2]
H_{ij}	-	Impedance	[F/L]
H_w	-	Inches of water	[L]
j	-	$\sqrt{-1}$	[-]
K	-	Direct stiffness	[F/L]
k	-	Cross-coupled stiffness	[F/L]
K_{ij}	-	Stiffness Coefficient	[F/L]
L	-	Seal Length	[L]
m_s	-	Stator mass	[M]
N	-	RPM	[1/T]
P	-	Pressure	[F/L^2]
P_i	-	Inlet Pressure	[F/L^2]
P_e	-	Exit Pressure	[F/L^2]
PR	-	Pressure ratio	[-]
PS	-	Preswirl ratio	[-]
R	-	Gas constant	[FL/(MT)]
$\ddot{R}$	-	Stator acceleration vector	[L/T^2]

T	-	Temperature	[T]
V_t	-	Inlet tangential (swirl) velocity	[L/T]
WFR	-	Whirl frequency ratio	[-]
X,Y	-	Displacement directions	[L]
$\dot{X},\dot{Y}$	-	Velocities	[L/T
ΔP	-	Differential Pressure	[F/L^2]
ε	-	Eccentricity Ratio	[-]
$\dot{m}$	-	Mass flow rate	[M/T]
$\dot{Q}$	-	Flow Rate	[L^3/T]
ρ	-	Density of gas	[M/L^3]
ρ_a	-	Density of air at STP	[M/L^3]
ρ_w	-	Density of water	[M/L^3]
Ω	-	Excitation Frequency	[1/T]
ω	-	Running speed	[1/T]

Subscripts

ij	-	Direction of response and force	[-]

INTRODUCTION

Gas seals are used in compressors and turbines to control the leakage of the working fluid. There are many different seal designs and each has different leakage and rotordynamic characteristics. Hole-pattern seals are essentially a plain seal that has had many radial holes drilled into the inner surface. Hole-pattern seals are gaining popularity in industry because they have shown similar characteristics to honeycomb seals. Honeycomb and now hole-pattern seals have been used to provide rotordynamic stability. Labyrinth seals were replaced with honeycomb seals in the High Pressure Oxygen Turbopump of the Space Shuttle Main Engine to solve synchronous and subsynchronous vibration problems Childs and Moyer [1]. But hole-pattern seals are easier and less expensive to manufacture than honeycomb seals.

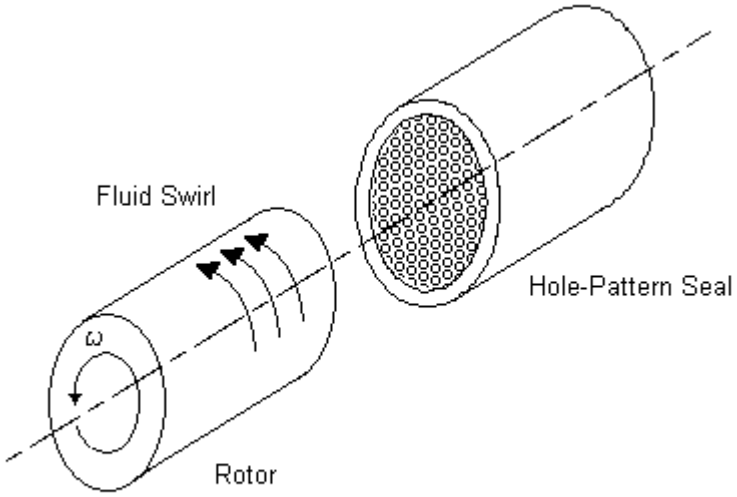

Figure 1. Hole-pattern seal

This thesis follows the style and format of the ASME Journal of Engineering for Gas Turbines and Power.

Figure 1 shows a hole-pattern seal with a smooth rotor. The arrows show the direction of the fluid preswirl. Sprowl [2] found that honeycomb seals are not very sensitive to fluid preswirl under the conditions of his testing. Finally in Figure 1, ω is the rotor speed.

$$-\begin{Bmatrix} f_{sX} \\ f_{sY} \end{Bmatrix} = \begin{bmatrix} K(\Omega) & k(\Omega) \\ -k(\Omega) & K(\Omega) \end{bmatrix} \begin{Bmatrix} X \\ Y \end{Bmatrix} + \begin{bmatrix} C(\Omega) & c(\Omega) \\ -c(\Omega) & C(\Omega) \end{bmatrix} \begin{Bmatrix} \dot{X} \\ \dot{Y} \end{Bmatrix} \quad (1)$$

The model for the reaction forces generated by hole-pattern seals is given by equation 1. K is the direct stiffness and k is the cross-coupled stiffness and they are functions of the excitation frequency (Ω). C is the direct damping and c is the cross-coupled damping, and they are functions of the excitation frequency (Ω).

This thesis will explore the effects of pressure ratio, preswirl, rotor speed, seal clearance, and choking on the rotordynamic coefficients and leakage of a of hole-pattern seal. Seals are tested under different conditions for several reasons. One reason is to determine the inherent characteristics of the hole-pattern seals. If the characteristics of the seals are known; then the seals don't have to be tested under the exact conditions that they will experience in service to know if the predicted rotordynamic coefficients are accurate. If the codes can predict the measurements well, the codes will have more credibility. The data in this thesis is compared to predictions generated by ISOTSEAL code. ISOTSEAL is a private code that was produced at the Texas A&M Turbomachinery Laboratory.

The seals have been tested at four different pressure ratios; three pressure ratios that resulted in non-choked flow through the seals and one pressure ratio that resulted in the seals experiencing choked flow. By having three test conditions that are not choked we can get a better feel for how the seals will behave in other unchoked conditions. One question that this thesis seeks to answer is whether or not there is a difference in the rotordynamic coefficients when a seal becomes choked. If there is a difference, what it is, and would be desirable or undesirable to operate a machine with seals in a choked condition?

The seals have been tested with three different fluid preswirls; zero, medium, and high. To determine how sensitive the seals' rotordynamic characteristics are to inlet fluid preswirl. If the seals are sensitive to inlet preswirl, technologies such as swirl brakes and shunt injection can be used to help the stability of the turbomachinery using hole-pattern seals.

The seals have been tested at three different rotor speeds to determine if the rotordynamic coefficients or seal leakage depend on the rotor speed. As the rotor speed increases, the circumferential shear on the fluid increases and as a result the fluid follows the rotor circumferentially inside the seal more as the rotor speed increases. The rotor also grows due to centripetal forces. As the rotor grows radially from centripetal forces, the clearance decreases.

The seals have been tested at two different clearances to examine how the rotordynamic coefficients and seal leakage are affected by the radial clearance.

All test conditions have been examined using ISOTSEAL to predict the rotordynamic coefficients and the leakage to validate the code. If the seal code is shown to be accurate then it can be used with more confidence while designing turbomachinery.

LITERATURE REVIEW

Experiments performed by Wachter and Benckert [3] showed that for labyrinth seals, reducing the circumferential flow velocity reduces the cross-coupled stiffness. Thus decreasing the circumferential flow velocity can increase the stability of a system.

Childs, Elrod, and Hale [4] were the first to perform dynamic tests with honeycomb seals. The rotor was shaken at frequencies from 30 Hz to 75 Hz; this allowed the direct and cross-coupled stiffness and damping to be measured.

Yu and Childs [5] tested different hole-pattern designs and compared them to a honeycomb seal. They found that the hole-pattern seals behave similar to honeycomb seals.

Dawson [6] tested two sets of honeycomb seals to examine the effects of straight bore seals versus a convergent taper bore. He found that the convergent tapered seals exhibited significantly larger effective stiffness and significantly less effective damping. The inlet pressure of the testing ranged from 6.9 bar-a (100 psi-a) to 17.2 bar-a (250 psi-a). He showed that the rotordynamic coefficients are frequency dependent.

Holt [7] performed tests on two sets of hole-pattern seals with different hole depths. The testing was conducted with two different inlet pressures from 6.9 bar-a (100 psi-a) to 17.2 bar-a (250 psi-a). He compared these results to smooth seal test results and also the straight bore honeycomb data from Dawson [6]. Holt found the highest effective stiffness values with the seals with the deepest holes. He also found that as the hole depth increased the seal leakage decreased.

Weatherwax and Childs [8] tested at high pressure 69 bar (1000 psi) and examined the effect of eccentricity. They found that the eccentricity of the rotor did not affect the rotordynamic coefficients even when the rotor was displaced up to 50% of the clearance.

THEORY AND MATHEMATICAL MODEL

The mathematical model suggested by Kleynhans and Childs [9], was used to reduce the data is shown below in equation 2.

$$-\begin{Bmatrix} f_{sX}(s) \\ f_{sY}(s) \end{Bmatrix} = \begin{bmatrix} G & E \\ -E & G \end{bmatrix} \begin{Bmatrix} X(s) \\ Y(s) \end{Bmatrix} \tag{2}$$

This equation is valid for small motion about the centered position. Equation 2 is presented in the Laplace domain, where s is the Laplace domain variable, f_s is the reaction force $X(s)$ and $Y(s)$ represent the Laplace domain components of the relative displacement between the rotor and stator. This model can be used to model seals that have rotordynamic coefficients that are affected greatly by the excitation frequency. If frequency dependent stiffness and damping coefficients are included in the seal model the resulting equation is shown below in equation 3.

$$-\begin{Bmatrix} f_{sX} \\ f_{sY} \end{Bmatrix} = \begin{bmatrix} K(\Omega) & k(\Omega) \\ -k(\Omega) & K(\Omega) \end{bmatrix} \begin{Bmatrix} X \\ Y \end{Bmatrix} + \begin{bmatrix} C(\Omega) & c(\Omega) \\ -c(\Omega) & C(\Omega) \end{bmatrix} \begin{Bmatrix} \dot{X} \\ \dot{Y} \end{Bmatrix} \tag{3}$$

The conversion between these two forms is

$$G(j\Omega) = K(\Omega) + jC(\Omega), \tag{4}$$

$$E(j\Omega) = k(\Omega) + jc(\Omega), \tag{5}$$

where $j = \sqrt{-1}$.

Other coefficients are also helpful when comparing seal behavior. The following coefficients are also only valid for forward whirl about the centered position. The equations for the effective stiffness, damping and cross-coupled stiffness are presented below in equations 6, 7, and 8.

$$K_{eff}(\Omega) = K(\Omega) + c(\Omega)\Omega \tag{6}$$

$$C_{eff}(\Omega) = C(\Omega) - \frac{k(\Omega)}{\Omega} \tag{7}$$

$$k_{eff}(\Omega) = k(\Omega) - C(\Omega)\Omega \tag{8}$$

DESCRIPTION OF THE TEST RIG

The test rig was originally designed to test high-speed hydrostatic bearings. A complete description of the original test stand configuration is included in Childs and Hale [10]. The rig was later altered to accommodate the testing of gas seals. Dawson [11] describes how the test rig was altered to allow the testing of annular gas seals with inlet pressure of up to 17.2 bar (250 psi). Later the test rig was modified again to allow the testing of annular gas seals at much higher inlet pressures of up to 84 bar-a (1235 psi-a). Weatherwax and Childs [8], explain how the test rig was altered to enable this high pressure testing. The test rig can spin the test rotor up to 29,000 RPM. There is a throttling valve down stream of the test seals and upstream of the exit labyrinth seals

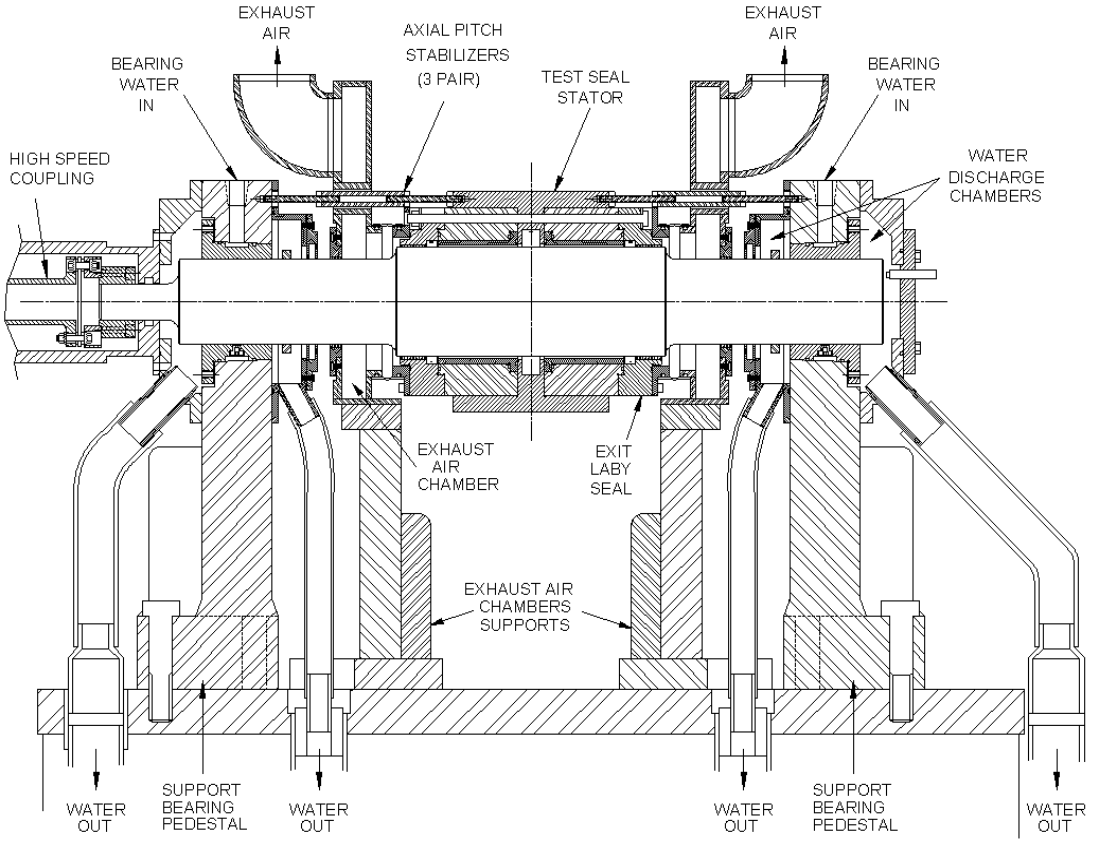

Figure 2. Cross-section of the test rig

that can be used to control the pressure drop across the test seals. The pressure ratio is defined as the exit pressure divided by the inlet pressure. The pressure ratios that can be achieved with the backpressure valve are from 0.1 to 0.7, depending on the leakage of the test seals. Figure 2 shows a cross section view of the test rig.

The rotor is supported on hydrostatic bearings. The hydrostatic support bearings are supplied with water at 69 bar-a (1000 psi-a). Two rotors are used to provide the two seal clearances. These rotors both have the same axial measurements. The only

Table 1. Seal dimensions

Seal 1				
Angle	Inlet		Outlet	
0	114.717 mm	(4.5164 in)	114.717 mm	(4.5164 in)
60	114.719 mm	(4.5165 in)	114.714 mm	(4.5163 in)
120	114.719 mm	(4.5165 in)	114.714 mm	(4.5163 in)
Average:	114.718 mm	(4.5165 in)	114.715 mm	(4.5163 in)

Seal 2				
Angle	Inlet		Outlet	
0	114.724 mm	(4.5167 in)	114.719 mm	(4.5165 in)
60	114.722 mm	(4.5166 in)	114.714 mm	(4.5163 in)
120	114.722 mm	(4.5166 in)	114.717 mm	(4.5164 in)
Average:	114.723 mm	(4.5166 in)	114.717 mm	(4.5164 in)

significant difference between the two rotors is their diameters under the test seals; one of the rotors has a 0.2 mm (8 mils) larger diameter than the other. The smaller rotor has a diameter of 114.3 mm (4.500 in). These dimensions result in a rotor-to-seal radial clearance of 0.2 mm (8 mils) for the seals tested. The larger rotor gives a radial clearance of 0.1 mm (4 mils). The test seal measurements are presented in Table 1. The seals were measured using a three-point gauge that is accurate to 0.00254 mm (0.0001 in). Each seal was measured in three locations, rotating 60 degrees between each measurement, at both the inlet of the seals and the outlet of the seal. As can be seen in Table 1 the seals were matched very well.

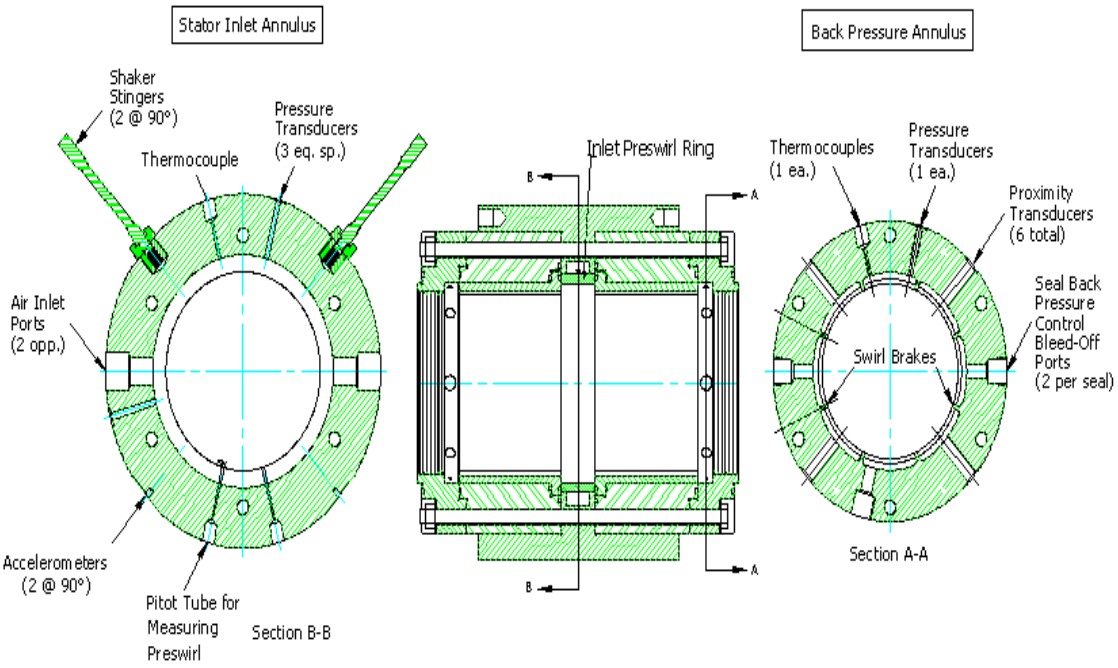

Figure 3. Test stator

The seals are held in a stator assembly during testing. Two orthogonal hydraulic shakers support the stator assembly and control the seal's radial position relative to the rotor. The stingers that the hydraulic shakers act through can be seen in Figure 3 Section B-B. There are three pitch stabilizers on each end of the stator; they are located in 120-degree increments around the rotor. The pitch stabilizers are constructed in three pieces so they can be preloaded. The pitch stabilizers attach axially between the stator and the hydrostatic bearing mounts. The pitch stabilizers control the stator's axial position. They also align the stator with the rotor so that there is not a pitch misalignment between the rotor and stator. By tightening the pitch stabilizers in the appropriate manner, the stator can be positioned so that it is aligned with the rotor.

During a test, high-pressure air enters at the middle of the stator through the inlet preswirl ring, and then exits through the two test seals. The exiting air then passes through swirl brakes before the exit labyrinth seals. The swirl brakes before the exit labyrinth seals minimize the cross coupled forces from the exit labyrinth seals.

The stator is instrumented to obtain the inlet and exit air pressure and temperature. At the inlet to the test seals, the circumferential velocity of the air is measured using a pitot tube. Once the circumferential velocity of the air is known, the fluid preswirl can be calculated. Force transducers that are in series with the stingers measure the force exerted on stator by the hydraulic shakers. Inline with the stingers, on the other side of the stator, there are accelerometers to measure the acceleration of the test stator in the two orthogonal directions corresponding to the directions the stator is shaken in.

The stator is shaken in each of the two orthogonal directions independently by the hydraulic shakers. The stator is shaken with a pseudo random waveform that contains frequencies from 20 Hz up to 360 Hz.

The motor used to control the speed of the rotor is a 93 kW (125 hp) AC electric motor. The rotor can be rotated at up to 29,000 RPM because it is driven by the electric motor through a Lufkin 6.960:1 step-up gearbox. A high-speed flexible coupling is used to link the test rotor to the gearbox.

Parameter identification

The stator is excited in two orthogonal directions as stated before. The equation for the stators motion is

$$\begin{Bmatrix} f_X \\ f_Y \end{Bmatrix} - \begin{Bmatrix} m_s \ddot{R}_{sX} \\ m_s \ddot{R}_{sY} \end{Bmatrix} = \begin{Bmatrix} f_{sX} \\ f_{sY} \end{Bmatrix} \tag{9}$$

where f is the measured excitation force, f_s is the seal reaction force, $\ddot{R}_s$ is the measured acceleration of the stator, and m_s is the stator mass. Restating equation 9 in the frequency domain yields,

$$\begin{Bmatrix} F_X - m_s A_X \\ F_Y - m_s A_Y \end{Bmatrix} = -\begin{bmatrix} H_{XX} & H_{XY} \\ H_{YX} & H_{YY} \end{bmatrix} \begin{Bmatrix} D_X \\ D_Y \end{Bmatrix} \tag{10}$$

where **F** and **A** are complex force and acceleration vectors expressed in the frequency domain, and the dynamic stiffness coefficient matrix defines the seal reaction forces. There are four unknowns $\mathbf{H_{XX}}$, $\mathbf{H_{XY}}$, $\mathbf{H_{YX}}$, and $\mathbf{H_{YY}}$.

To solve for the four unknowns the stator is shaken in two orthogonal directions, X and Y. By shaking in two orthogonal directions four independent equations are obtained with four unknowns given by equation 11.

$$\begin{bmatrix} F_{XX} - m_s A_{XX} & F_{XX} - m_s A_{XX} \\ F_{XX} - m_s A_{XX} & F_{XX} - m_s A_{XX} \end{bmatrix} = -\begin{bmatrix} H_{XX} & H_{XY} \\ H_{YX} & H_{YY} \end{bmatrix} \begin{bmatrix} D_{XX} & D_{XY} \\ D_{YX} & D_{YY} \end{bmatrix} \tag{11}$$

Equation 11 is valid for small motion about the centered position, equation 11 has been verified by previous tests. Also the assumption is made that k_{XY} is equal to $-k_{YX}$; the data supports this assumption. The stiffness and damping terms are found directly from the impedances.

$$K(\Omega) = \mathrm{Re}\left(H_{ii}(\Omega)\right) \tag{12}$$

$$k(\Omega) = \mathrm{Re}\left(H_{ij}(\Omega)\right) \tag{13}$$

$$C(\Omega) = \frac{\mathrm{Im}\left(H_{ii}(\Omega)\right)}{\Omega} \tag{14}$$

$$c(\Omega) = \frac{\mathrm{Im}\left(H_{ij}(\Omega)\right)}{\Omega} \tag{15}$$

Test seals

The hole-pattern seals described in this thesis have similar geometries to seals that exhibited negative stiffness when they were tested at the Turbomachinery Laboratory. Hole-pattern seals are not normally expected to produce negative stiffness.

The seals have been machined out of 6061 aluminum. The holes are 3.175 mm (0.125 in) in diameter and 3.302 mm (0.130 in) deep. Gamma is a way to describe how close together the holes are, gamma is equal to the area of the holes divided by the area of the inner surface of the seal. The test seals have a gamma of 0.69; therefore, 69% of the inner surface is taken up by holes. The seals are 85.725 mm (3.375 in) long and as shown in Table 1 the diameter of the seals is an average of 114.717 mm (4.5164 in), therefore this seals have a L/D ratio of 0.75. Figure 4 shows the important dimensions of the test seals.

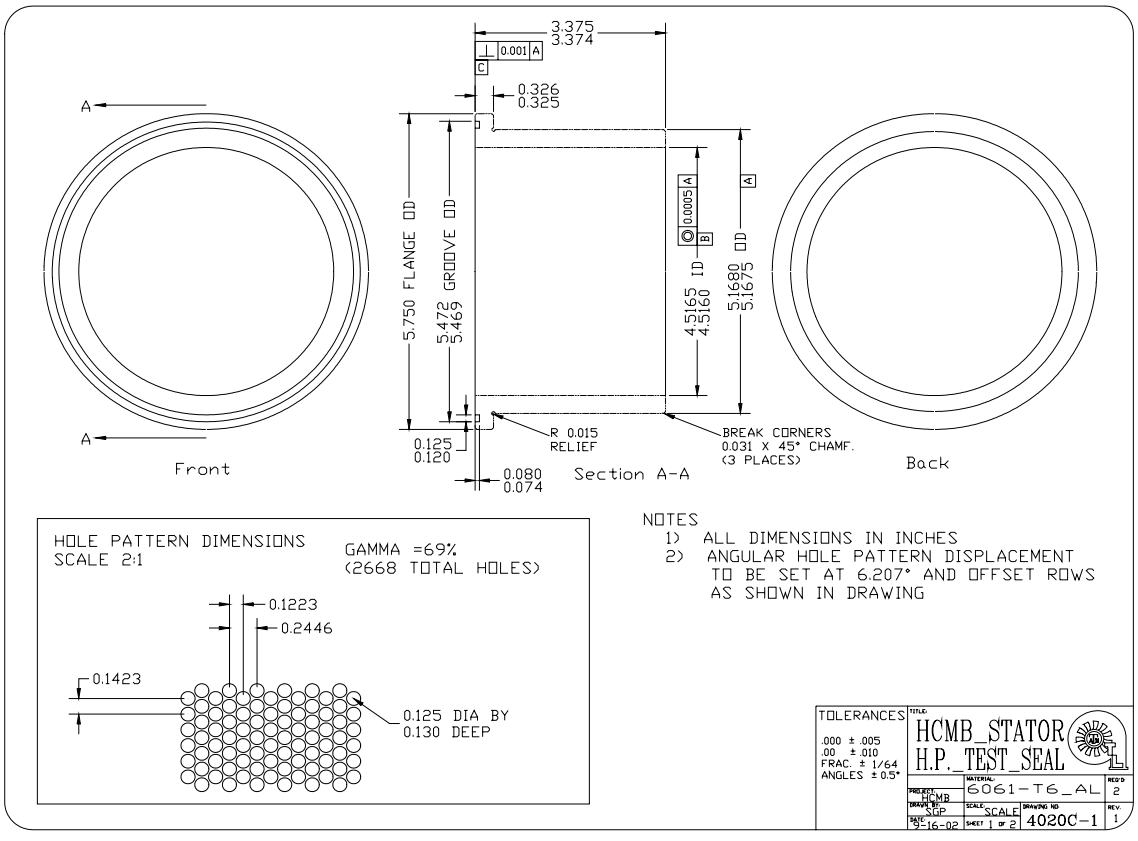

Figure 4. Drawing of the test seals

Fluid preswirl

Circumferential fluid flow causes cross-coupled stiffness and damping terms. Some seals are more sensitive to fluid rotation and produce larger cross-coupled terms given the same fluid swirl conditions. Some of the test matrix conditions for the seals were chosen to explore how the seals respond to various inlet swirl conditions. Figure 5 shows a cross-section of the different preswirl rings.

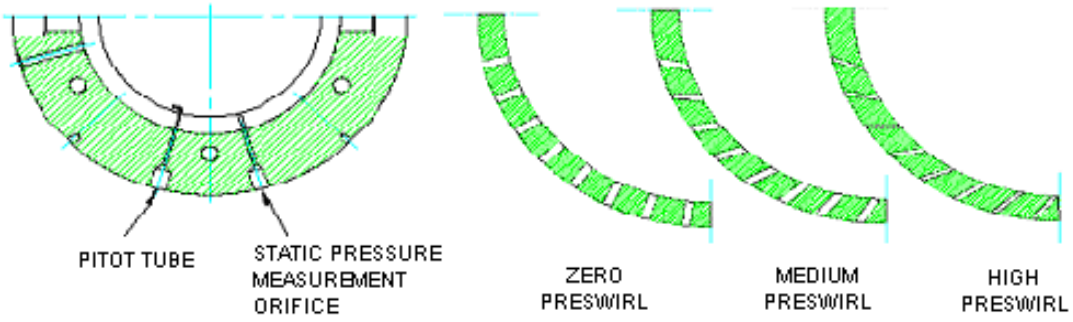

Figure 5. Cross-section view of the preswirl rings

Fluid preswirl ratio is defined as the fluid's inlet circumferential velocity divided by the rotor's surface speed, equation 16.

$$Ratio_{pre-swirl} = \frac{V_t \cdot 60}{\pi \cdot N \cdot D_r} \tag{16}$$

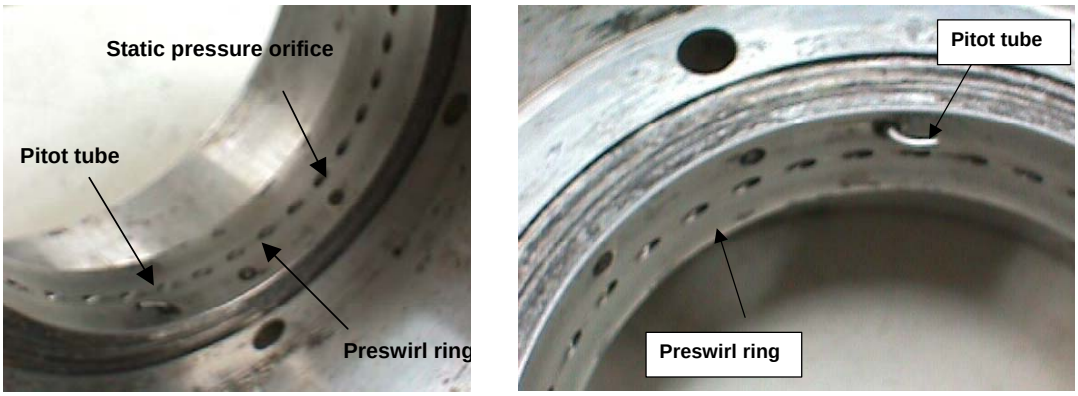

Figure 6. Preswirl ring and preswirl measurement

A preswirl ratio of 1.0 means that the fluid enters the seal with a speed equal to the surface velocity of the rotor, and a value of 0.5 means that the fluid is rotating at half of the rotor's surface speed. Also, a negative preswirl ratio value would indicate that the fluid is rotating against the direction of rotation of the rotor.

This test rig measures the fluid circumferential velocity using a pitot tube located at the inlet annulus; it measures the fluid swirl immediately before the fluid enters the test seals. The pitot tube can be seen in Figure 6. The fluid circumferential velocity is calculated based on the pressure differential between the static and stagnation pressures measured in the inlet annulus. Figure 6 shows the stator inlet annulus, and the preswirl ring is visible. The inlet annulus is also shown in the stator diagram show in Figure 3 Section B-B.

The preswirl ring in the inlet annulus directs the air circumferentially. The high-pressure air is feed into the inlet annulus and then flows through the preswirl ring before entering the test seals. Three levels of preswirl rings were tested, and they are called,

zero, medium, and high. The zero preswirl ring has holes that are radial, injecting the air radially onto the rotor. The medium preswirl ring is designed to give the incoming air a preswirl ratio of approximately 0.5, for the medium rotor speed of 15,200 RPM. And the high preswirl ring is designed to produce a preswirl ratio of approximately 1.0, again with a rotor speed of 15,200 RPM. Figure 5 shows a cross-section view of the three preswirl rings and how the rings are different to result in the different preswirl values. Figure 5 also shows another view of the pitot tube and static pressure measurement orifice.

Leakage flow

All annular seals allow a certain amount of leakage to occur. Leakage dependents on many factors, but the main factors in determining how much mass flow a given annular gas seal will allow in a given situation are, the pressure drop across the seal, the radial clearance between the rotor and the seal, the length of the seal, and the relative roughness of the seal and rotor surfaces.

The test rig measures the volumetric flow rate of air that flows through the rig by a turbine style flow meter up stream of the test seals. The flow meter is located between the inlet control valve and the inlet annulus of the test stator, and measures the total flow through both seals. Since the seals are physically as close to identical as possible, and the pressure drop across both seals is measured and found to be approximately the same the flow is assumed to be split evenly between each seal.

The temperature and pressure of the air passing through the flow meter are also measured and used to convert from volumetric flow rate to the mass flow rate. As the test is running, the volumetric flow rate, the temperature, and the pressure of the air is recorded five times before a shaking test is run. These five samples are recorded while the test rig is operating in a steady state condition, the five data points are then averaged and the average value is reported.

Test conditions

The test seals were tested in a variety of conditions; four pressure ratios, three preswirls, three rotor speeds, and two seal clearances, with a total of 72 different test conditions. The test matrix is presented in Table 2.

The inlet pressure for all test conditions was maintained at approximately 70 bar-a (1015 psi-a). The pressure of the inlet air was controlled to plus or minus 1 bar (~15 psi) or better. The test rig does not control the temperature of the inlet air. Since the temperature of the incoming air was not controllable, it was recorded, to be used later to make corrections for air density. Relative humidity of the incoming air is also not controlled. The relative humidity of the air was not measured.

Table 2. Test matrix

Pre-Swirl	Rotor Speed	Radial Seal Clearance	Pressure Ratio
(-)	(N)	(mm)	(-)
Zero	10,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
	15,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
	20,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
Medium	10,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
	15,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
	20,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
High	10,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
	15,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47
	20,200	0.10, 0.20	0.17, 0.27, 0.37, 0.47

EXPERIMENTAL RESULTS

Baseline data

To account for the stiffness and damping that are not produced by the test seals, baseline data are measured. This baseline data is obtained by assembling the test rig without seals in the test stator. The stator is pressurized, and with the rotor spinning, the stator is shaken and data recorded. This step is taken to measure the forces that result from the exit labyrinth seals and the stiffness and damping of the stator assembly. The

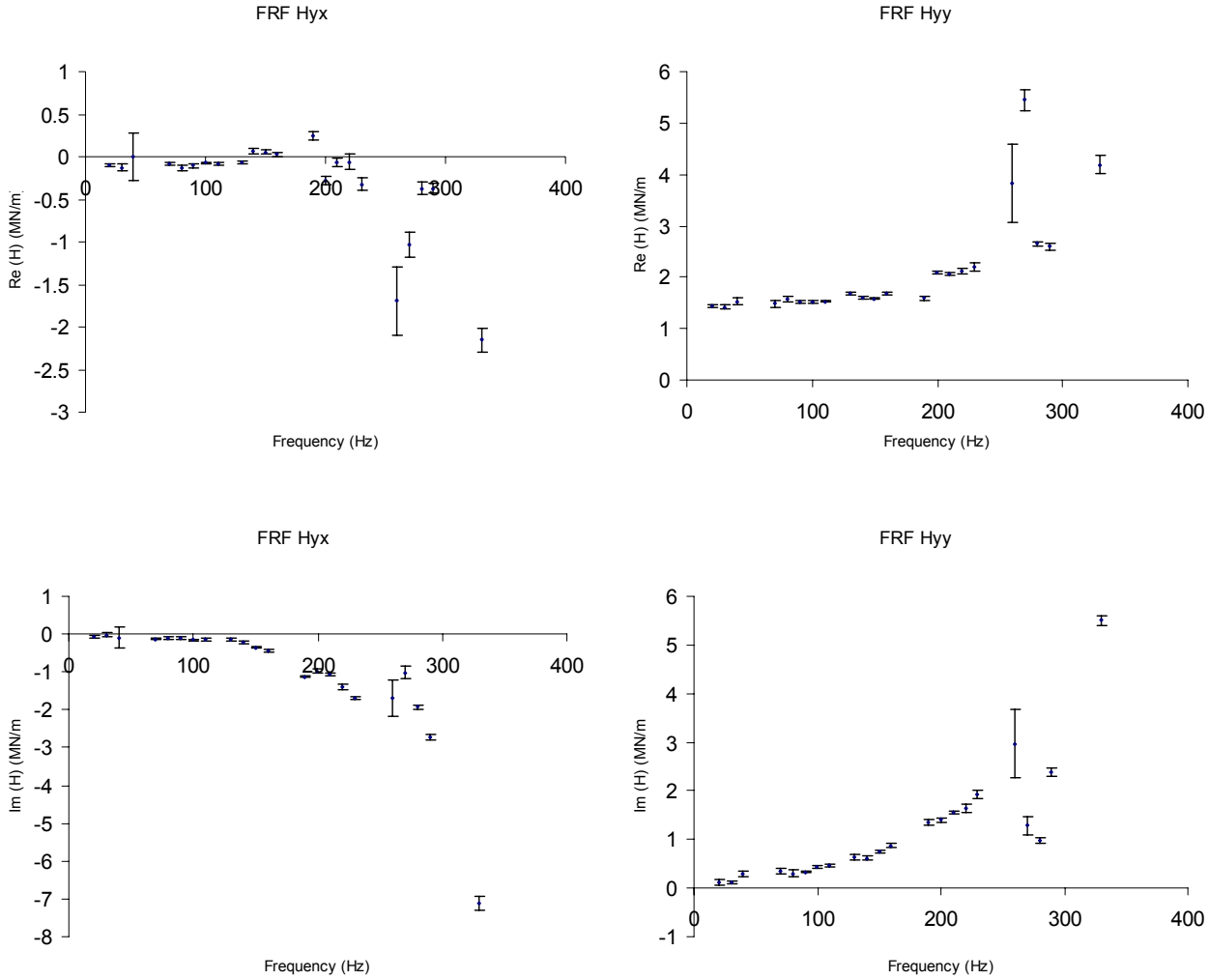

Figure 7. Baseline data

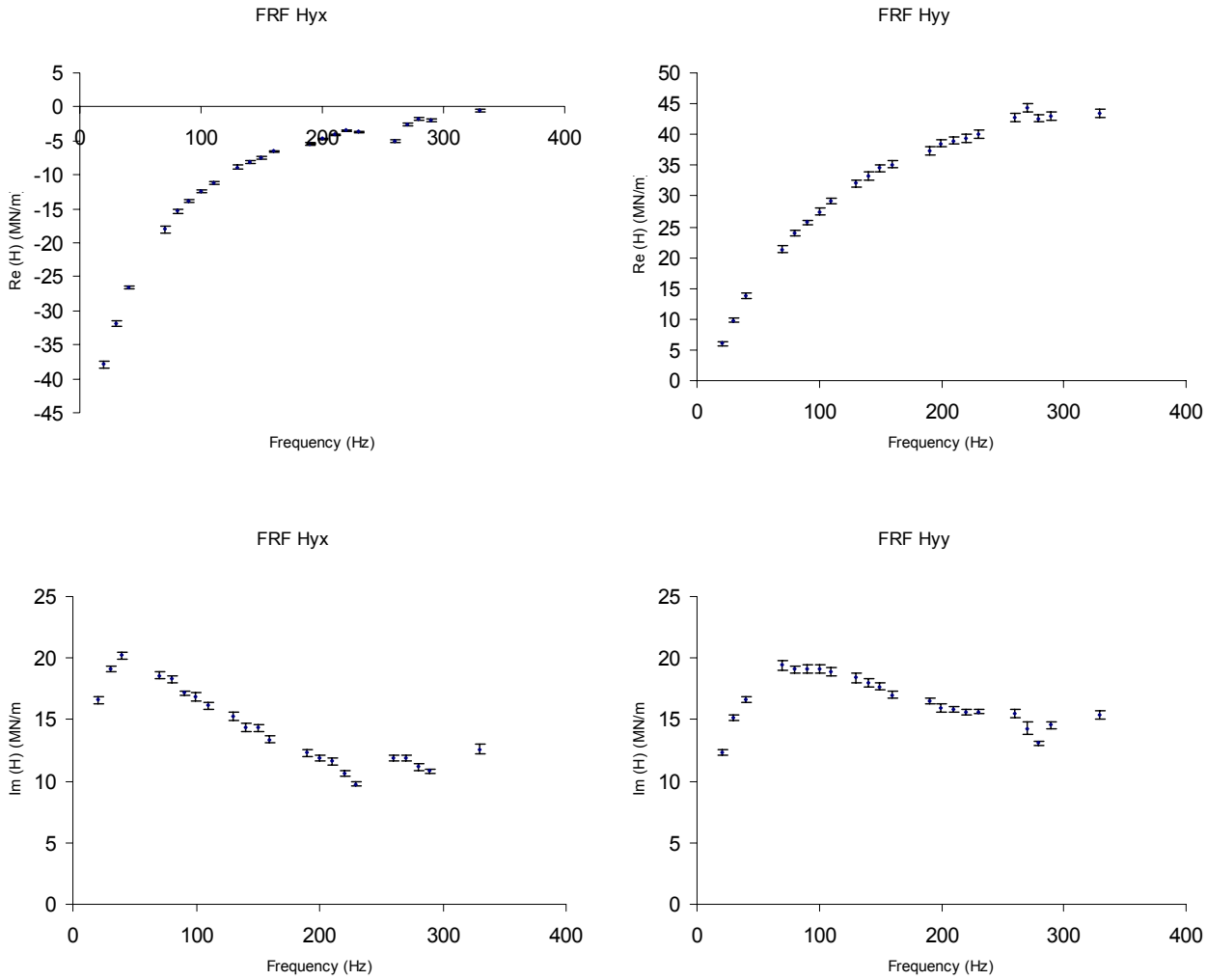

Figure 8. Raw test data

baseline real and imaginary impedances are subtracted from the corresponding real and imaginary impedances produced with the test seals installed. Figure 7 shows a plot of the baseline data used in the reduction of data that has a backpressure of approximately 11.3 bar-a (165 psi-a). The data is only presented for the “Y” direction for brevity sake; the data taken in the “X” direction was similar. Figure 8 shows an example of some raw test data that would have the baseline shown in Figure 7 subtracted from it. Notice that the baseline data has significantly smaller impedances than the test data. The baseline data used in the data reduction is selected to have approximately the

same pressure drop across the exit labyrinth seals. As an example of the finished result of the baseline subtraction Figure 9 shows the test data with the baseline subtracted. The baseline data does not change the general shape of the impedances; nor does the baseline subtraction affect the values of the impedances reported significantly. This is a good outcome; because it means that the uncertainty associated with small changes in the test rig will not have a strong effect on the measurement of seal coefficients.

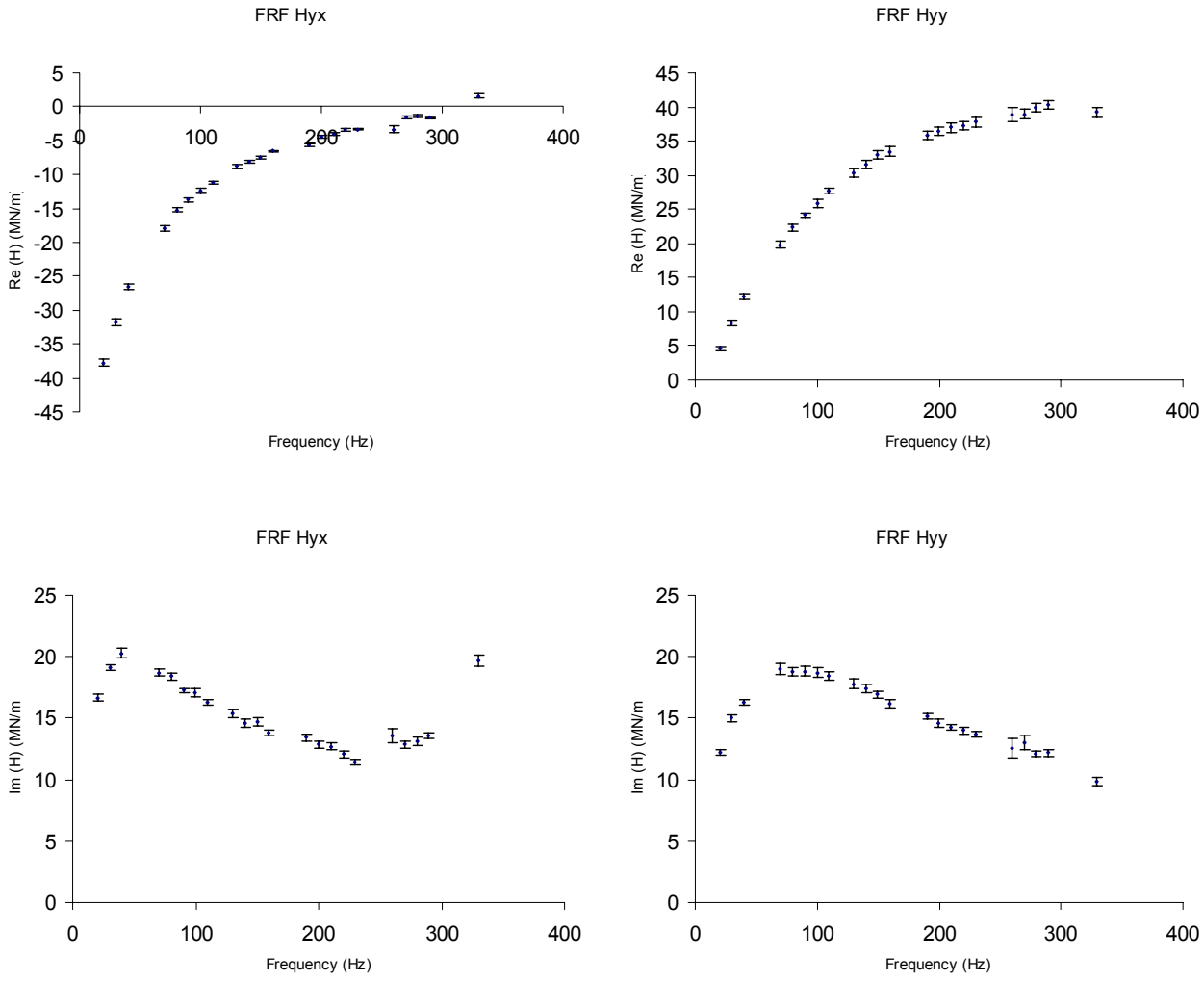

Figure 9. Test data with baseline subtracted

Test data uncertainty

There is some uncertainty with any measurement. With these experiments, there is uncertainty in the measurements of force, acceleration, pressure, temperature, and rotor speed. Kurtin et al. [12] performed uncertainty analysis for the static coefficients of the test rig. These uncertainties are presented in Table 3.

Table 3. Static parameter's uncertainties

Shaft Speed	Preassure	Flow Rate	Eccentricity Ratio
(N)	(P)	($\dot{Q}$)	(e)
10 RPM	3.747 kPa	0.177 L/min	0.005

To obtain an uncertainty value for the impedances, a single dynamic test was repeated ten times. The uncertainty of the impedances was found in this manner for each assembly. During testing at the highest pressure ratio (0.47), the 15,200 RPM rotor speed test was repeated ten times. These data were then reduced to calculate the stiffness and damping terms. The standard deviation of the each term at the discrete frequencies is then calculated. The standard deviation of the term is plotted as uncertainty bars on the data graphs, as can be seen in Figures 7, 8 and 9 above.

Uncertainty data were taken in the same manner for the baseline data. An example of the uncertainty of the baseline data can be seen in Figure 7. The uncertainty shown in Figure 8 is the uncertainty of the test data alone. All of the data that is reported in this thesis with the baseline subtracted the uncertainty of both the test data and the baseline data are combined. Equation 17 shows how the uncertainties are combined.

$$U_{total} = \sqrt{U_{Baseline}^2 + U_{Test\_data}^2} \tag{17}$$

Figure 9 shows the result of the combined uncertainties.

DISCUSSION OF RESULTS

Direct and cross-coupled stiffness

By the nature of the test matrix, test results that are presented seek to determine how the test seals react to changes in pressure ratio, inlet preswirl, rotor speed, and radial clearance.

The direct and cross-coupled stiffness coefficients come from the real part of the impedances as shown in equations 12 and 13. Figure 10 shows these coefficients plotted versus frequency. The data presented is the average of the direct and cross-coupled stiffnesses measured in the X and Y directions. Unless otherwise noted, all the data presented is the average of the values recorded from both directions. The top two

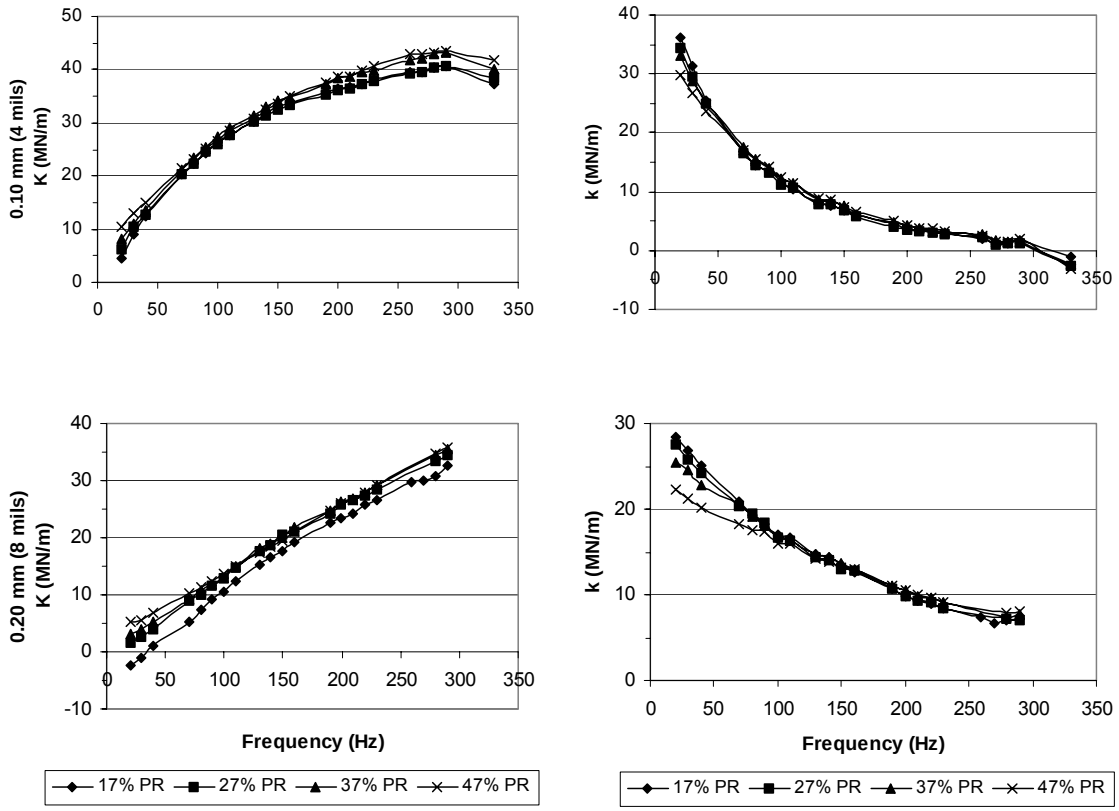

Figure 10. Direct and cross-coupled stiffness coefficients for all pressure ratios with the high inlet preswirl and $\omega = 20{,}200\,RPM$

graphs in Figure 10 correspond to the 0.10 mm (4 mils) radial-clearance data; the bottom two graphs are for the 0.20 mm (8 mils) radial-clearances. The direct and cross-coupled stiffnesses are not strongly affected by the pressure ratio. Also notice that the 17% PR conditions, which are choked, do not result in significant or noticeable changes in the coefficients when compared to the other pressure ratios that are not choked.

The results of Figure 11 show that the inlet preswirl does not affect the direct stiffness significantly for both clearances. The cross-coupled stiffness resulting form the

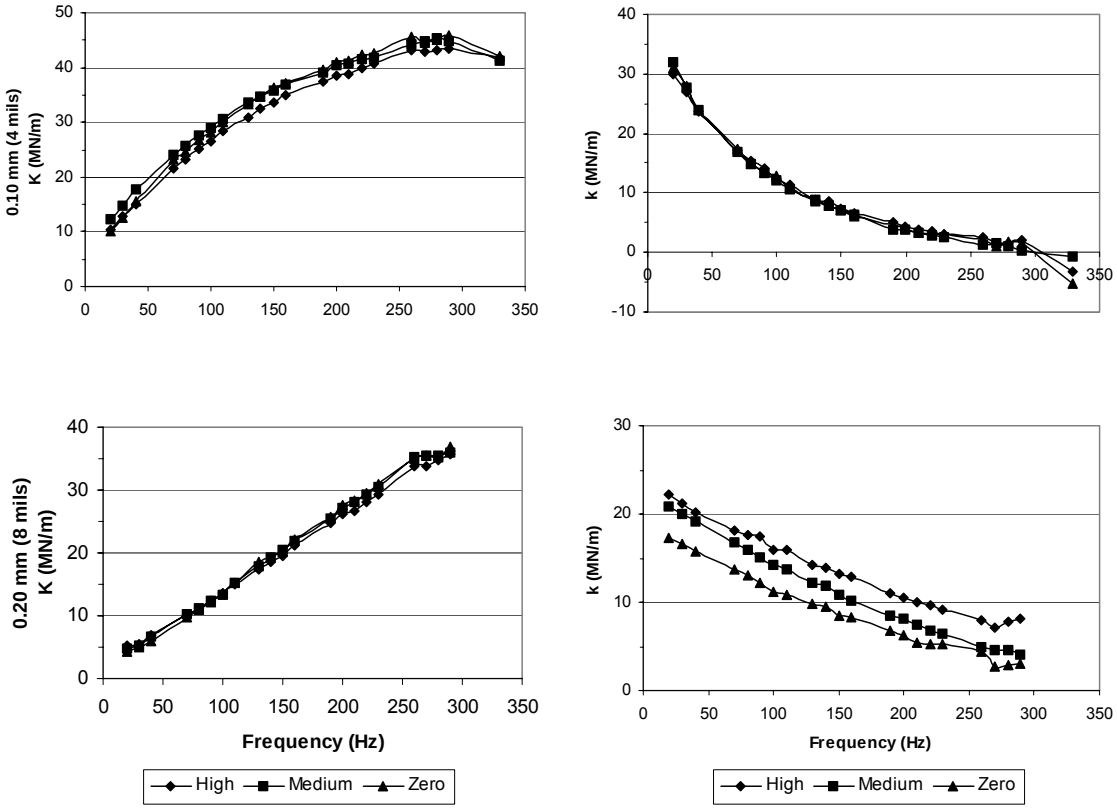

Figure 11. Direct and cross-coupled stiffness coefficients for all preswirls, $PR = 47\%$, $\omega = 20{,}200 RPM$

0.10 mm (4 mils) radial clearance testing is also not significantly affected by the inlet preswirl. However the cross-coupled stiffness measured with the 0.20 mm (8 mils) radial clearance is strongly affected by the inlet preswirl. The cross-coupled stiffness increases with increasing inlet preswirl for the large clearance condition.

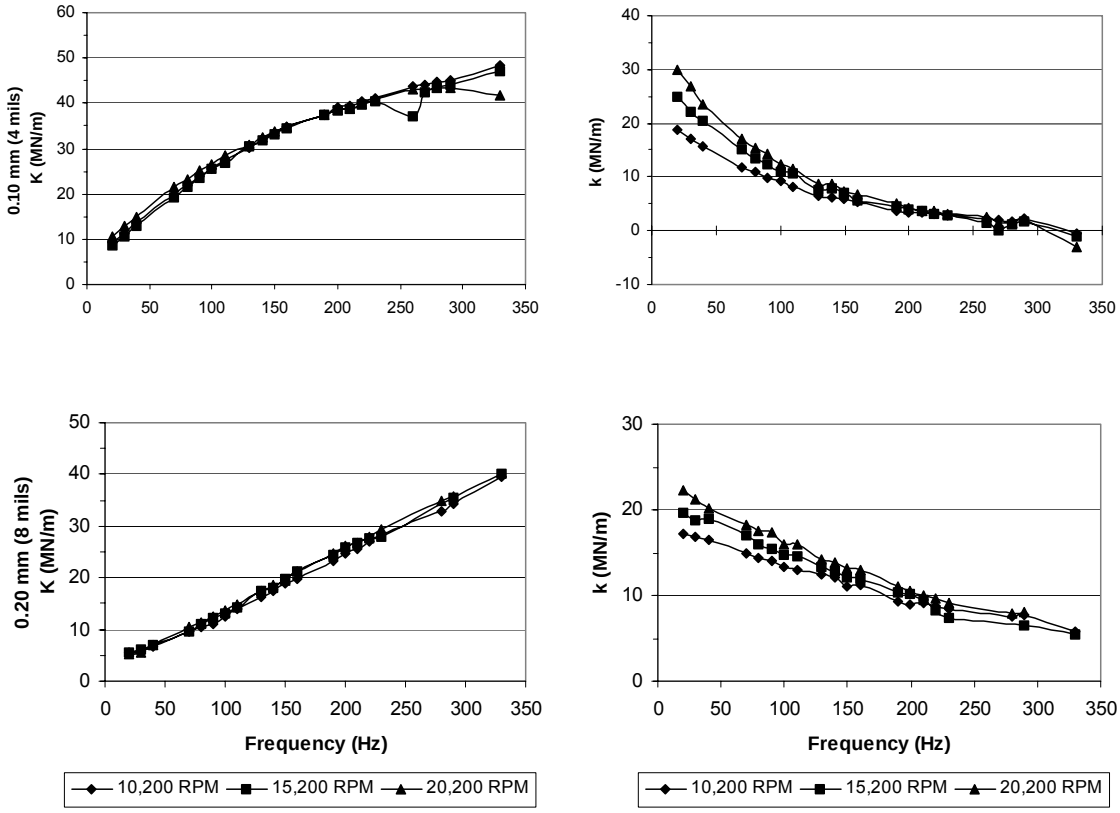

Figure 12. Direct and cross-coupled stiffness coefficients for various rotor speeds with high preswirl, and $PR = 47\%$

The rotor speed's influence on the direct and cross-coupled stiffness is illustrated in Figure 12. The direct stiffness is not drastically affected by the rotor speed. As expected the cross-coupled stiffness increases with increasing rotor speed, because increasing the rotor speed increases the average circumferential velocity of the fluid.

Figures 10, 11, 12, and 13 show that there is a difference in the direct and cross-coupled stiffnesses based on the rotor to seal clearance. In all cases the larger clearance data shows a more linear relation between direct and cross-coupled stiffness and frequency than the smaller clearance data. Also, the smaller clearance seals produced higher direct stiffness coefficients than the larger clearance tests. The cross-coupled stiffness shown in Figure 13 is generally larger for the smaller clearance data at low frequencies and then crosses the larger clearance data and is smaller at frequencies above approximately 60 Hz. Recall from Figure 11 that the cross-coupled

stiffness is not noticeably affected by the inlet preswirl in the 0.10mm (4 mils) data but does with the larger clearance 0.20 mm (4 mils) cross-coupled stiffness.

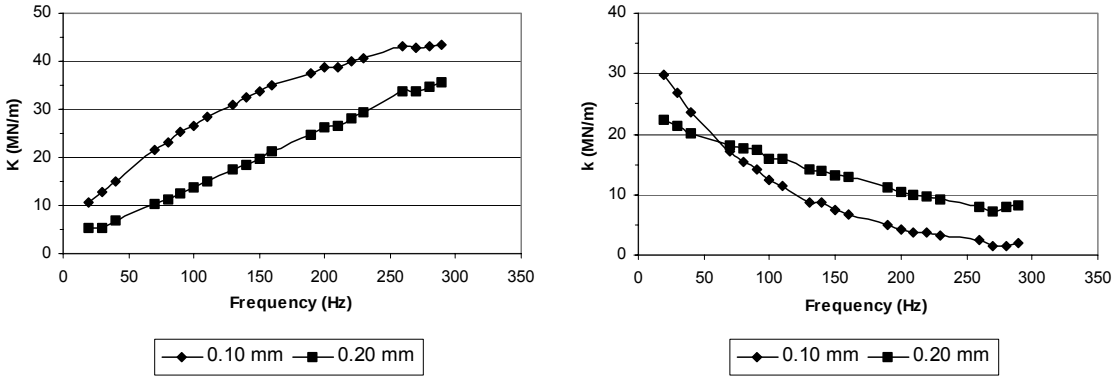

Figure 13. Direct and cross-coupled stiffness coefficients for both clearances with high preswirl, and $\omega = 20{,}200 RPM$

Direct and cross-coupled damping

Again, recall that the test matrix was chosen to examine how the test seals react to changes in pressure ratio, inlet preswirl, rotor speed, and the rotor to seal clearance. Now, we will look at how these variables affect the direct and cross-coupled damping.

As shown in equations 14 and 15, the direct and cross-coupled damping coefficients come from the imaginary part of the impedances. Figure 14 illustrates the behavior of the direct and cross-coupled damping that were measured for the test seals. The data are the average of the direct and cross-coupled damping measured in the X and Y directions. The top two graphs in Figure 14 are for the smaller 0.10 mm (4 mils);

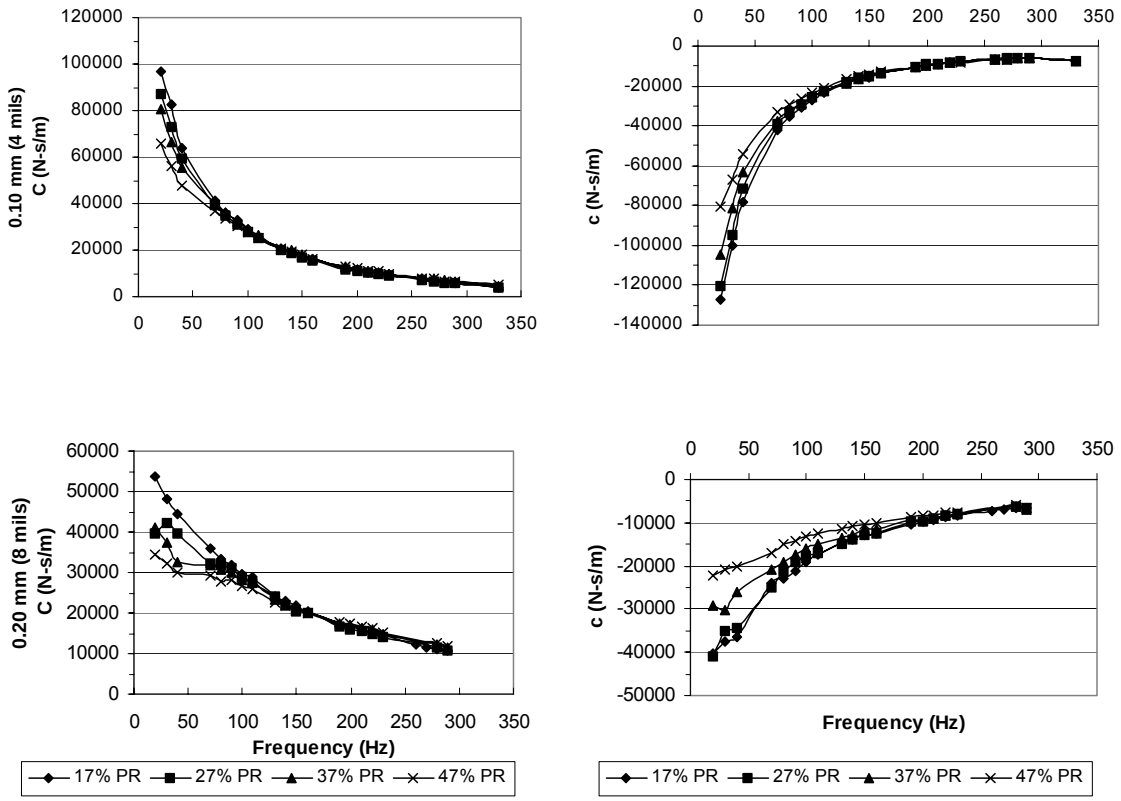

Figure 14. Direct and cross-coupled damping coefficients for all pressure ratios with the high inlet preswirl and $\omega = 20{,}200 RPM$

radial clearance the bottom two graphs are from the larger 0.20 mm (8 mils) radial

clearance. With the smaller radial clearance of 0.10mm (4 mils) the direct and cross-coupled damping are not strongly affected by the pressure ratio for the data taken. With the larger clearance the data shows some dependence on the pressure ratio at lower frequencies. The 17% pressure ratio data is choked flowing through the test seals, notice that there is not a significant change in the shape or trend of the direct or cross-coupled damping coefficients.

Figure 15 shows the average of the direct and cross-coupled damping

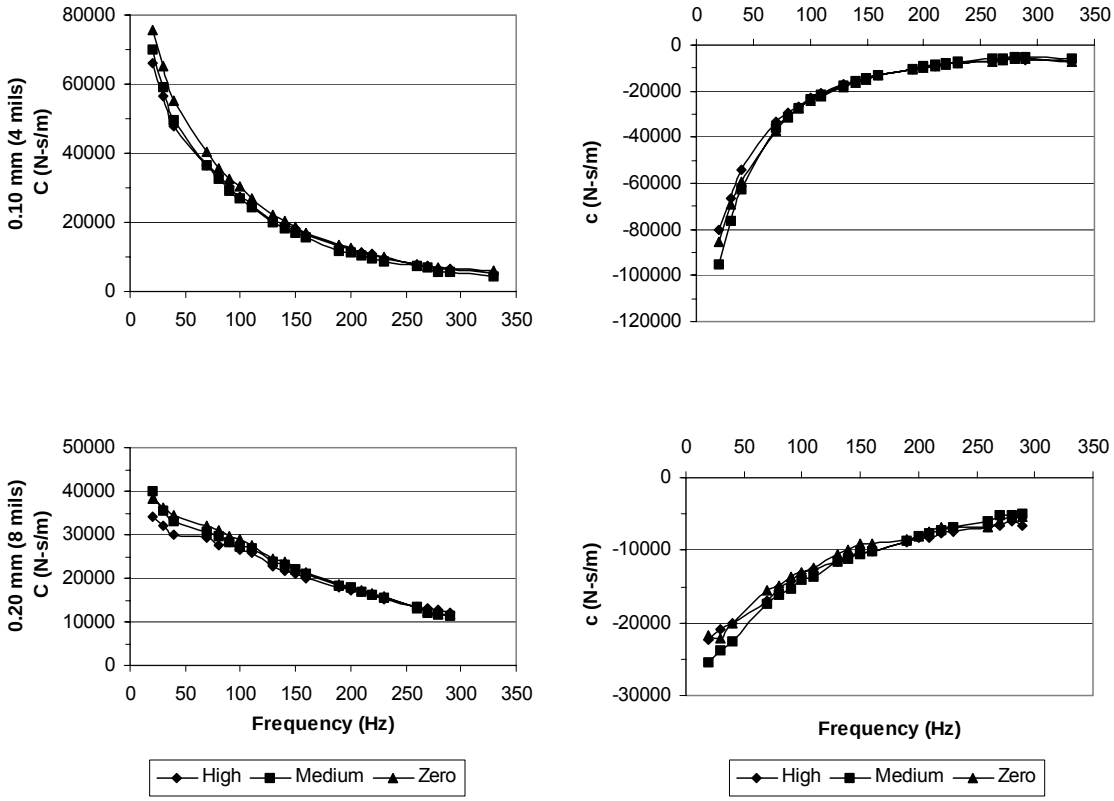

Figure 15. Direct and cross-coupled damping coefficients for all preswirls, $PR = 47\%$, $\omega = 20{,}200 RPM$

measured in the X and Y direction with a 47 percent pressure ratio and a rotor speed of 20,200 RPM. It can be seen in Figure 15 that the inlet preswirl does not affect the direct or cross-coupled damping significantly for either clearance.

The rotor speeds influence on direct and cross-coupled damping coefficients is illustrated in Figure 16. These data were all taken with the high preswirl, and the direct stiffness is not drastically affected by the rotor speed. The direct damping is not significantly affected by the rotor speed for both clearances. The cross-coupled damping increases with increasing rotor speed for each of the clearances.

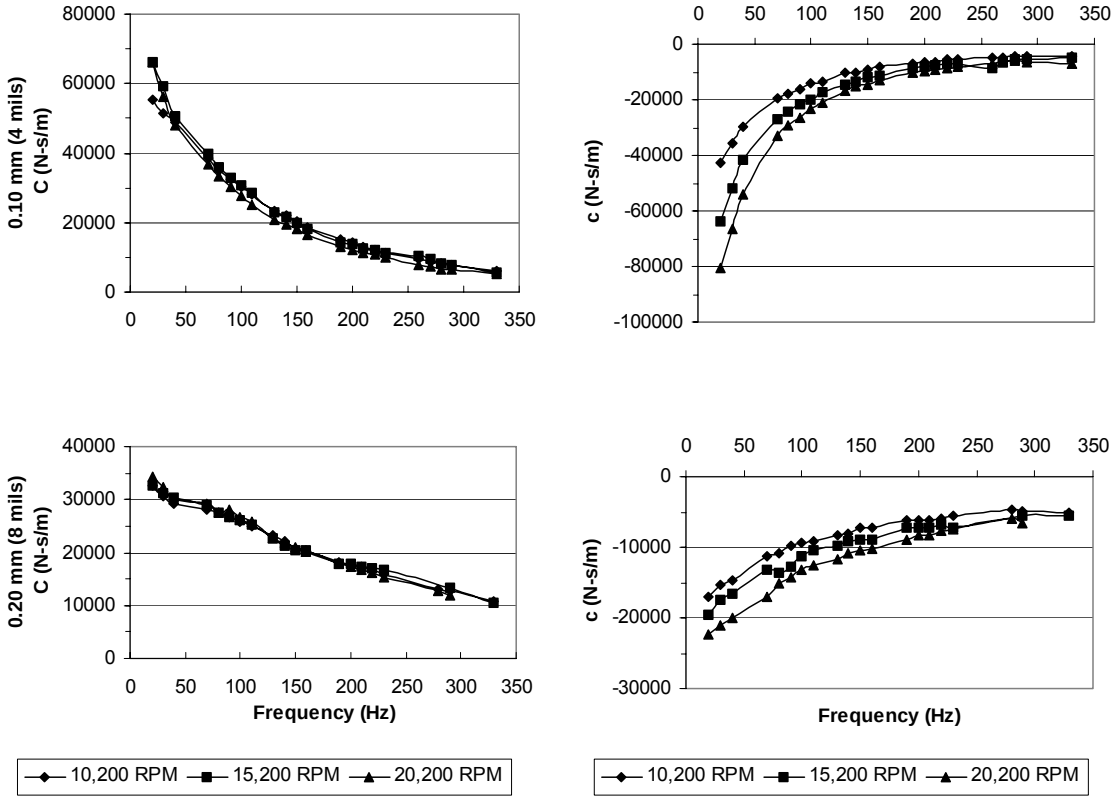

Figure 16. Direct and cross-coupled damping coefficients for various rotor speeds with high preswirl, and $PR = 47\%$

Figures 14, 15, 16, and 17 show dependence in the direct and cross-coupled damping coefficients to the seal clearance. In all cases, the larger clearance data shows a more linear relation between direct and cross-coupled damping and frequency than

the smaller clearance data shows. Also, the smaller clearance produced higher coefficients at the lower frequencies. Figure 17 shows data recorded with the high preswirl ring and a rotor speed of 20,200 RPM. The larger clearance data has larger damping coefficients at frequencies above approximately 100 Hz.

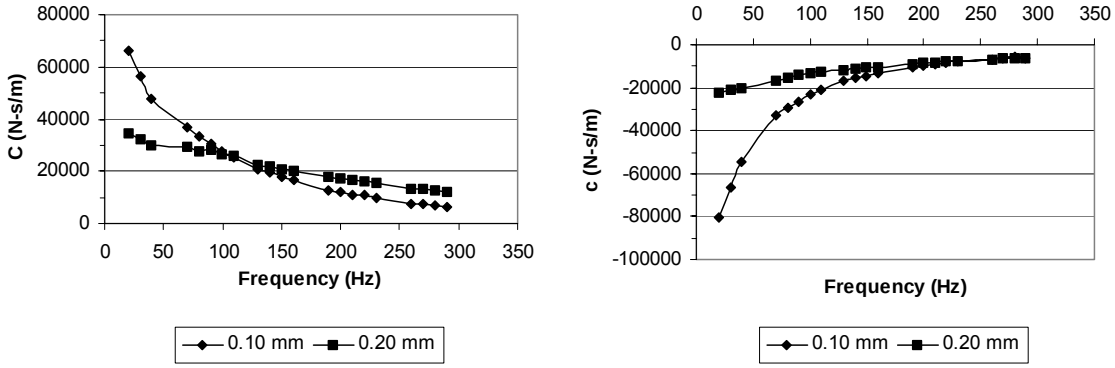

Figure 17. Direct and cross-coupled damping coefficients for both clearances with high preswirl, and $\omega = 20{,}200 RPM$

Seal leakage

Figure 18 provides an example of how the leakage is affected by the changes in preswirl for the different pressure ratios, showing that the inlet preswirl does not significantly affect leakage. The data presented in Figure 18 were all recorded with a rotor speed of 10,200 RPM. The error bars plotted with the test data represent one standard deviation and are very small (0.0035 kg/s). No significant difference in the leakage characteristics was observed from the data at the other faster speeds. As can be seen in Figure 18, ISOTSEAL predicts the seal leakage very well, showing slightly better predictions for the 0.20 mm (8 mils) radial clearance data than the smaller clearance test. ISOTSEAL is based on a bulk flow model and uses a Blasius friction factor model of the form shown in equation 18

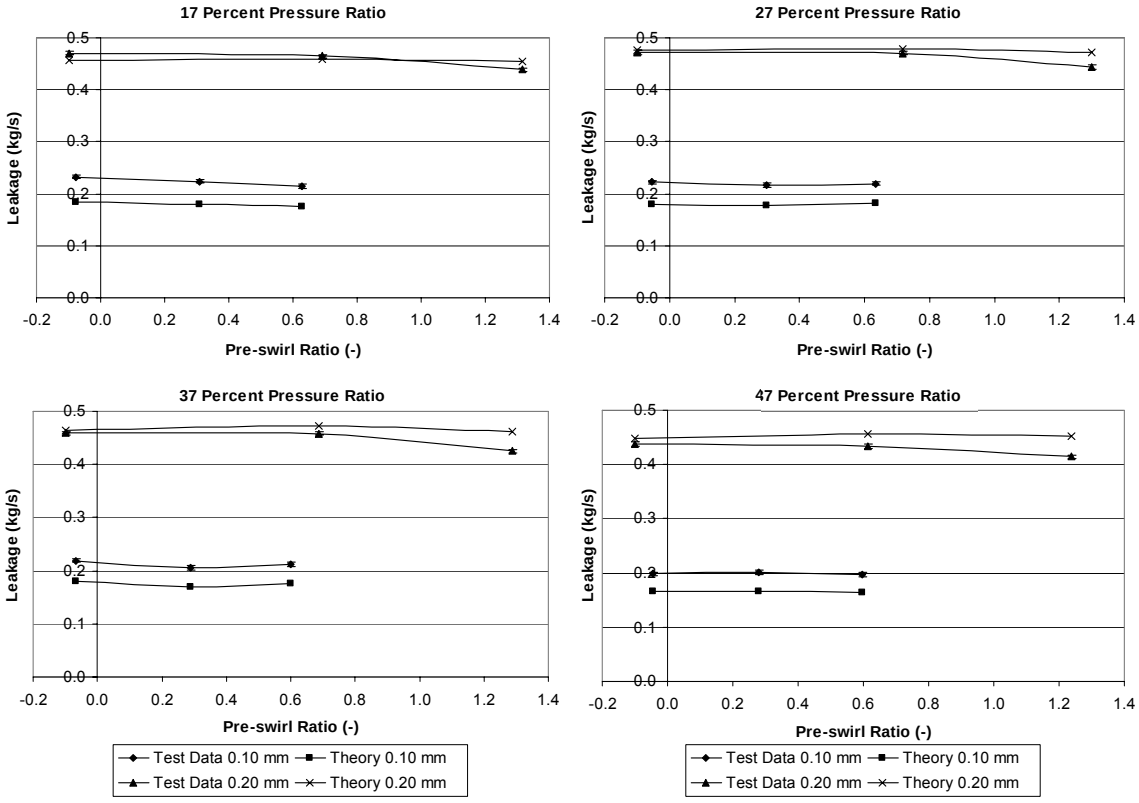

Figure 18. Leakage versus inlet preswirl, $\omega = 10{,}200\,RPM$

$$f_f = n\,\mathrm{Re}^m \tag{18}$$

The values that were used in the Blasius friction factor model were the default values that were selected by Kleynhans [13], $n_{Rotor} = 0.0586$, $m_{Rotor} = -0.2170$, $n_{Seal} = 0.0785$, and $m_{Seal} = -0.0110$.

Discharge coefficient

A discharge coefficient can be used for the test seals to easily compare the leakage characteristics of seals under different test conditions. The discharge coefficient appears in a simple equation that only involves the inlet and exit pressures the rotor to seal radial clearance and the inlet temperature. The equation is shown in equation 14 below. This equation is altered from Childs [14] book.

$$\dot{m} = C_{Discharge}\, 2\pi RH \sqrt{\frac{P_{Inlet}^2 - P_{Exit}^2}{RT_{Inlet}}} \tag{14}$$

Where $R = 286.7\frac{J}{kg \cdot K}$ is the gas constant for air, T_{Inlet} is the temperature of the inlet air in degrees Kelvin, P_{Inlet} is the seal inlet pressure in Pascal, P_{Exit} is the seal exit pressure in Pascal, **H** is the radial rotor-to-seal clearance in meters, and **R** is the radius to the center of the clearance in meters. Using equation 14 one coefficient was found to be valid for both clearances.

As can be seen in Figure 19 the calculated discharge coefficients for all of the test data collapses together, indicating that the formula used to calculate the discharge coefficient is useful for the test seals. Regardless of the inlet pressure, the discharge coefficient is centered about 0.25; the actual mathematical average value is 0.249. The 0.10 mm radial clearance data produces slightly lower discharge coefficient values than the 0.20 mm radial clearance data. The discharge coefficient is not significantly affected by preswirl as would be expected based on the very small changes in flow rate

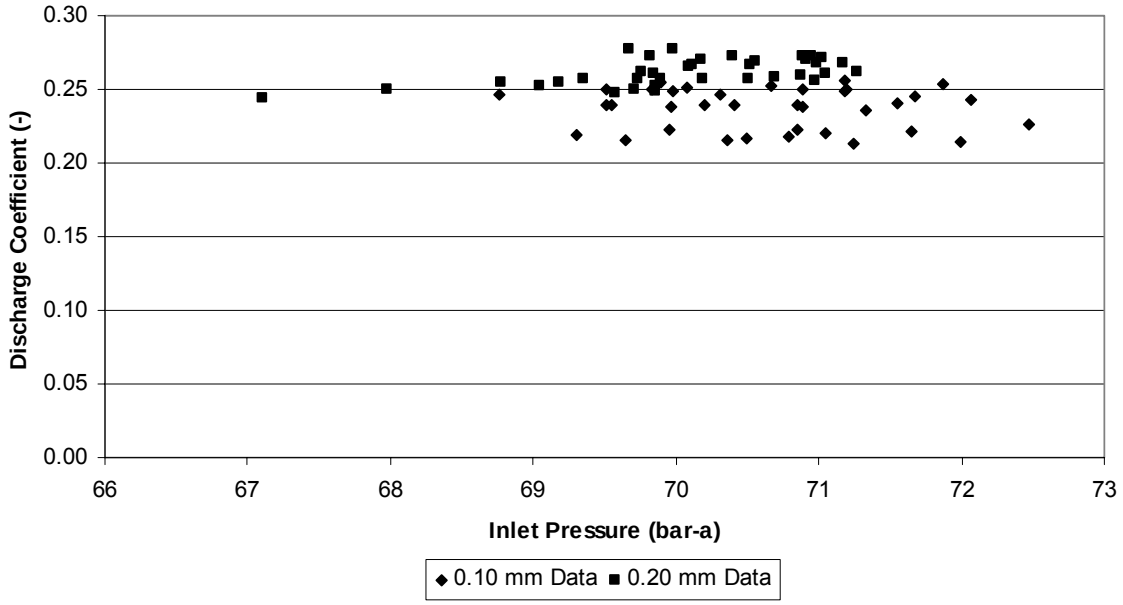

Figure 19. Calculated discharge coefficient for all data

observed with changes in preswirl that was noted in the previous section. Different pressure ratios and the different radial clearance are accounted for quite well by the discharge coefficient.

Effective cross-coupled stiffness

The effective cross-coupled stiffness gives an indication of whether the system or in this case the seal will have a stabilizing or destabilizing effect. A negative value for the effective cross-coupled stiffness indicates that the seals will have a stabilizing effect. The equation for calculating the effective cross-coupled stiffness was presented earlier in equation 8.

Note that the effective cross-coupled stiffness and the effective damping represent the same physical quantity. There are some important differences between the effective damping and the effective cross-coupled stiffness. For effective damping, a positive value corresponds to a stabilizing effect; with the effective cross-coupled stiffness a negative value represents a stabilizing effect. However, the most important difference between the two representations is the effective damping equation includes a term that is divided by frequency. Therefore, as the frequency goes to zero effective

damping goes to negative infinity, making it difficult to present the effective damping as a function of frequency. For the effective cross-coupled stiffness there is no division by frequency so this term remains bounded. Therefore the effective cross-coupled stiffness is easier to present than the effective damping.

Figure 20 shows an example of the effect that the different pressure ratios had on the effective cross-coupled stiffness. The data were taken with high inlet preswirl and a rotor speed of 20,200 RPM. The pressure ratio plays little to no role in determining the effective cross-coupled stiffness. Also note that the seals are destabilizing at lower

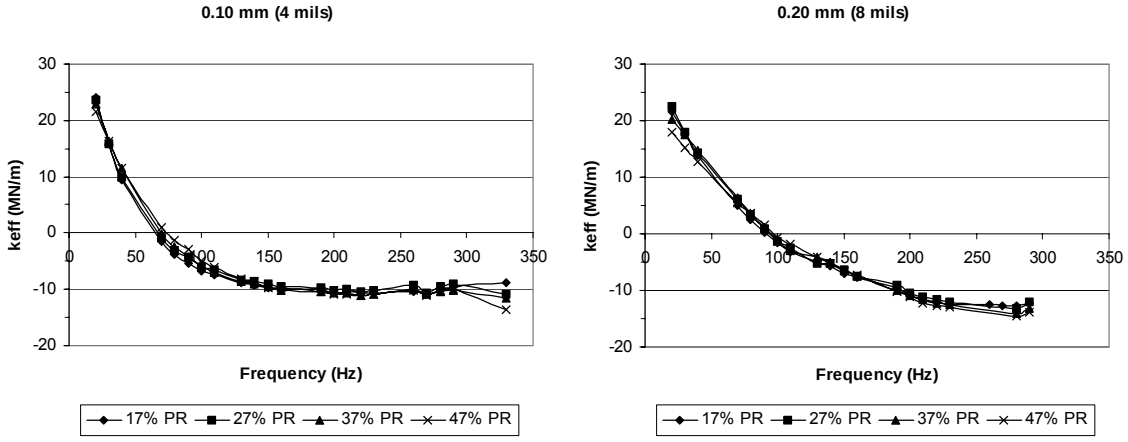

Figure 20. Effective cross-coupled stiffness coefficients versus pressure ratio with the high inlet preswirl and $\omega = 20{,}200 RPM$

frequencies and then become stabilizing at higher frequencies.

The data presented in Figure 21 shows the effect that the inlet preswirl has on the effective cross-coupled stiffness. The data that is presented was recorded during the 47 percent pressure ratio test with a rotor speed of 20,200 RPM. The data shows that inlet preswirl has little affect on the effective cross-coupled stiffness for the smaller clearance data. But there is a significant affect on the larger clearance data with changes in the inlet preswirl. Preswirl changes the magnitude and also changes the crossover frequencies. The crossover frequency is the frequency where the effective cross-coupled stiffness is equal to zero, where the effective cross-coupled stiffness transitions from destabilizing to stabilizing.

Figure 22 shows the influence of rotor speed on the effective cross-coupled stiffness. The data presented in Figure 22 were obtained during the high preswirl tests. With both clearances the crossover frequency increases with the rotor speed, although the increase is more pronounced in the smaller clearance data.

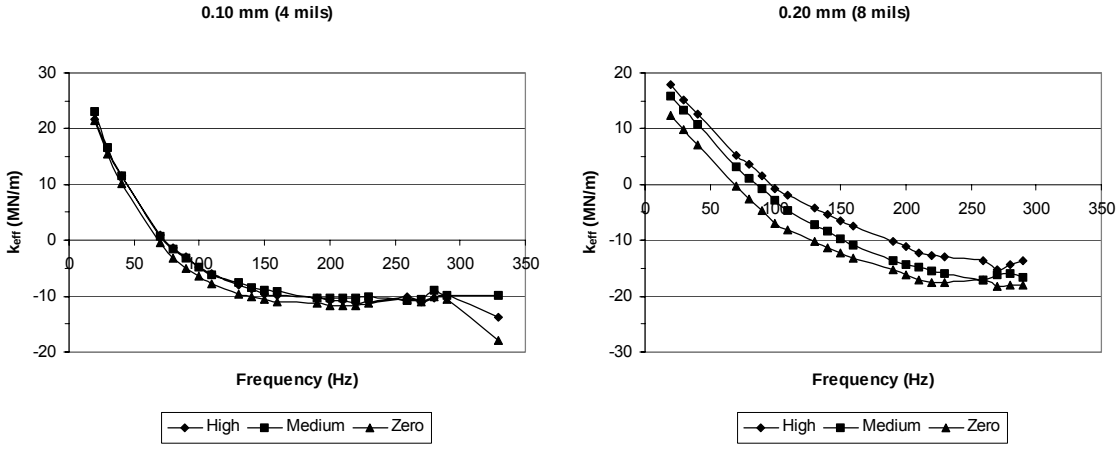

Figure 21. Effective cross-coupled stiffness coefficients versus inlet preswirl, $PR = 47\%$, $\omega = 20{,}200 RPM$

Figure 23 shows the effective cross-coupled stiffness for both clearances plotted on the same graph. The data shown were measure with a 47 percent pressure ratio, high inlet fluid preswirl, and a rotor speed of 20,200 PRM. There is little difference between the data taken at the different clearances in regards to the actual magnitudes of the data, but again there is a difference in the crossover frequency. The 0.10 mm (4 mils) data becomes stabilizing at approximately 75 Hz while the 0.20 mm (8 mils) data does not become stabilizing until it reaches approximately 100 Hz.

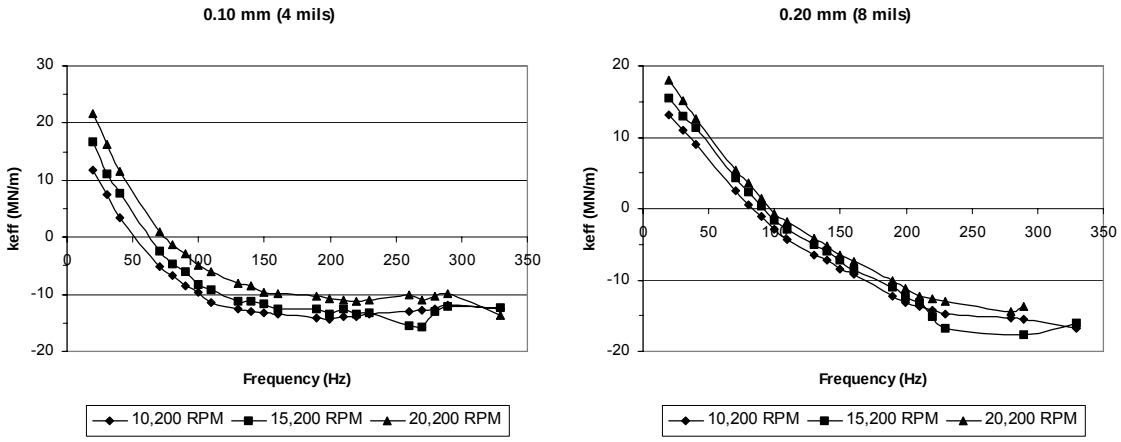

Figure 22. Effective cross-coupled stiffness coefficients versus rotor speed with high preswirl, and $PR = 47\%$

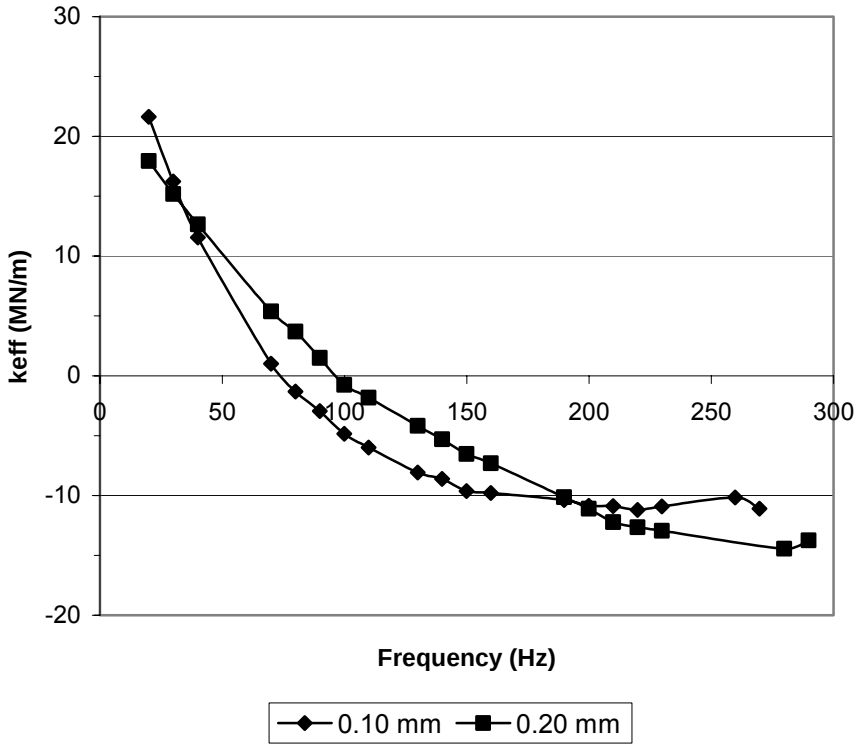

Figure 23. Effective cross-coupled stiffness coefficients for two radial clearances with high preswirl, and $\omega = 20{,}200 RPM$

EXPERIMENT VERSUS THEORETICAL PREDICTIONS

This section will present the rotordynamic coefficients that where measured and the rotordynamic coefficients that ISOTSEAL predicted. The data contains the uncertainty bars that result from the dynamic uncertainty described above. The uncertainty bars represent one standard deviation.

Direct and cross-coupled stiffness

Figure 24 shows the direct stiffness that was measured, the data points with the uncertainty bars, and the predicted value, the solid line. These data were measured for the smaller clearance with the high preswirl condition with a rotor speed of 20,200 RPM. The theory tends to under predict the direct stiffness. As the pressure ratio increases the predicted values become more accurate.

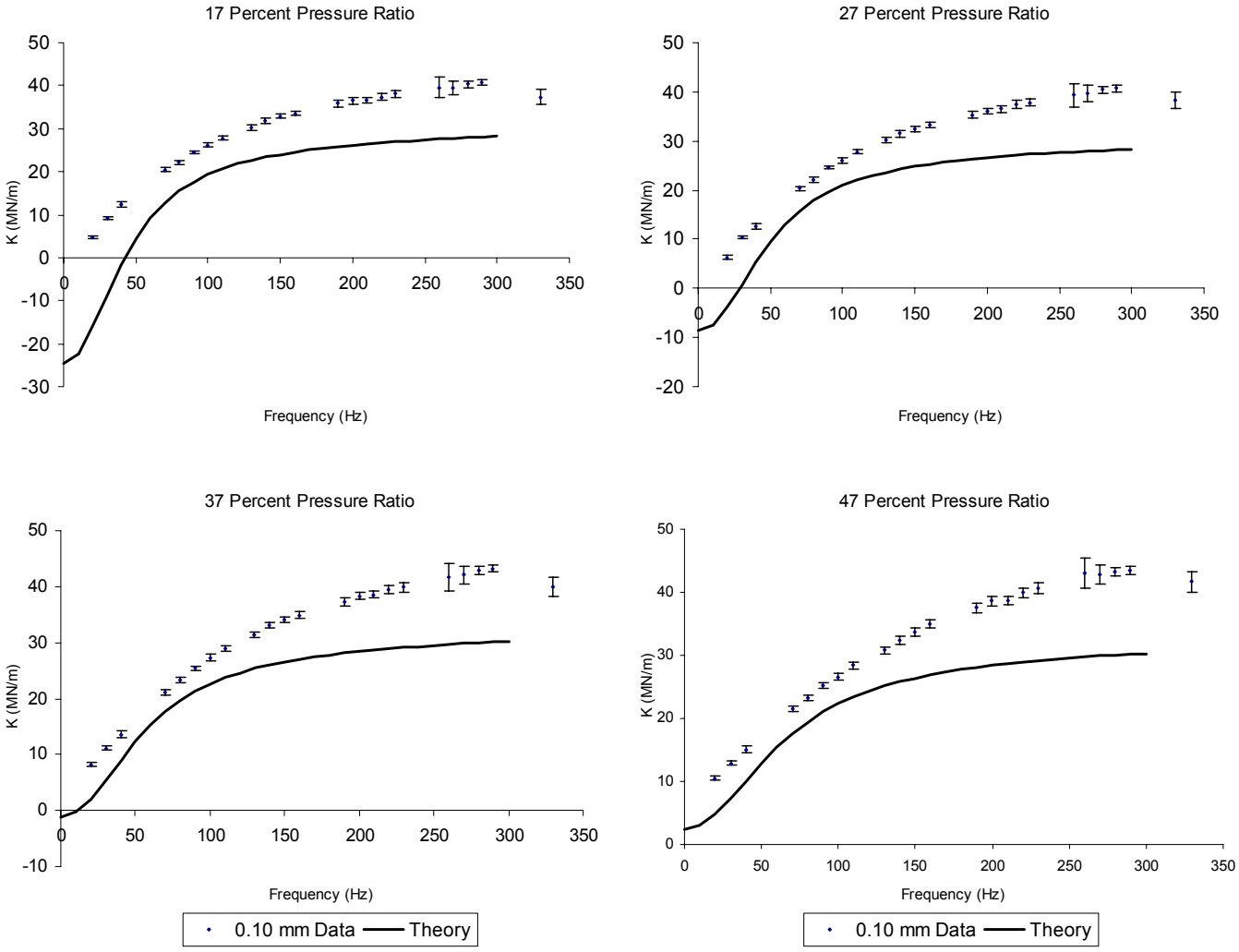

Figure 24. 0.10 mm data direct stiffness coefficients versus excitation frequency for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200\,RPM$

Figure 25 shows the cross-coupled stiffness coefficients versus excitation frequency for the four pressure ratios that were tested. These data were collected with the small clearance during the high inlet preswirl condition, with a rotor speed of 20,200 RPM. The code does a very good job of predicting the cross-coupled stiffness for all pressure ratios.

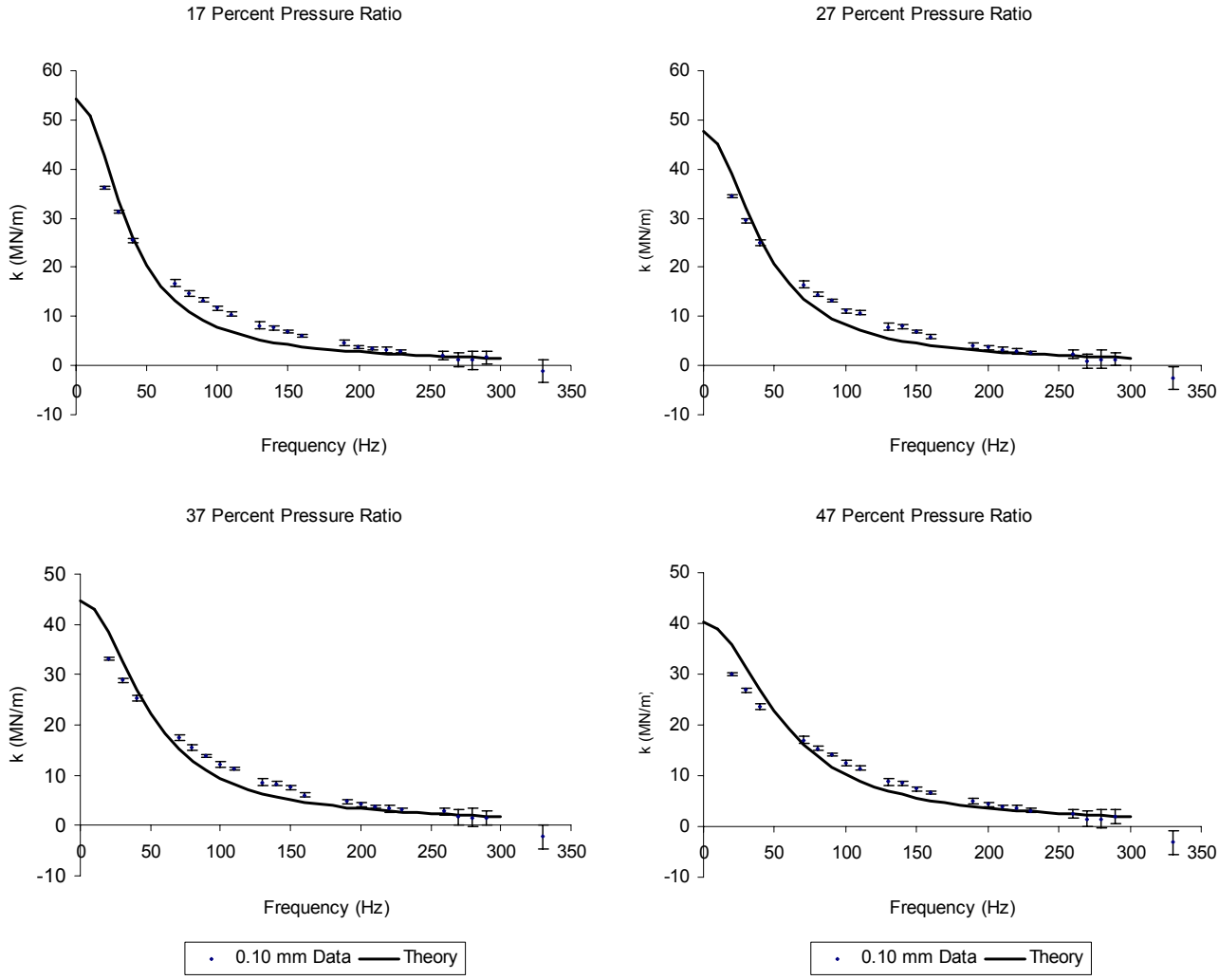

Figure 25. 0.10 mm data cross-coupled stiffness coefficients versus excitation frequency for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200 RPM$

Figure 26 shows the direct stiffness coefficients for high preswirl at 20,200 RPM rotor speed, but with the larger clearance. The prediction accuracy for these data is a little better than at the smaller clearance. This outcome is representative of all the data; the direct stiffness is generally predicted better at the larger clearance. Also, notice that again the code predicts more accurately at the higher pressure ratios.

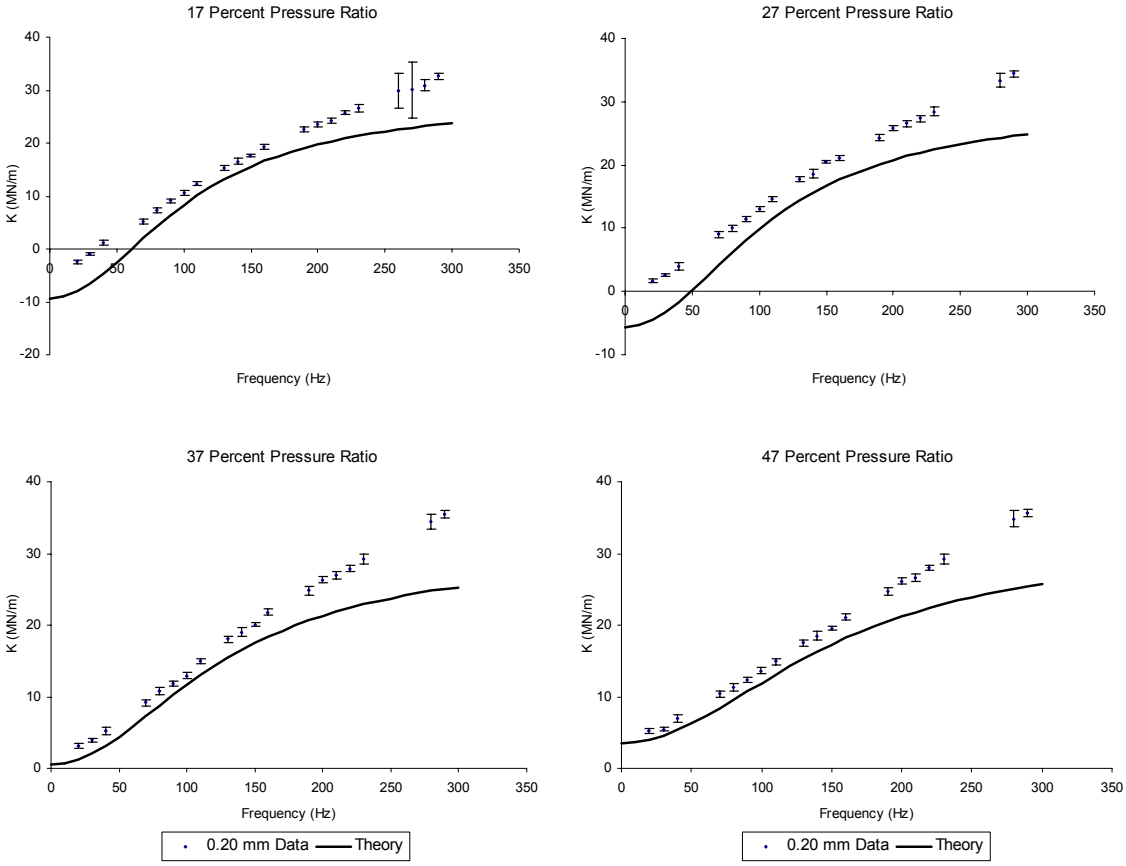

Figure 26. 0.20 mm data direct stiffness coefficients versus excitation frequency for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200 RPM$

Figure 27 shows the measured and predicted values for the cross-coupled stiffness of the seals at the larger clearance with high preswirl and a rotor speed of 20,200 RPM. The code still does a good job of predicting the coefficients, and does marginally better at predicting the cross-coupled stiffness at the smaller clearance. There is not much change in accuracy with changes in the pressure ratio.

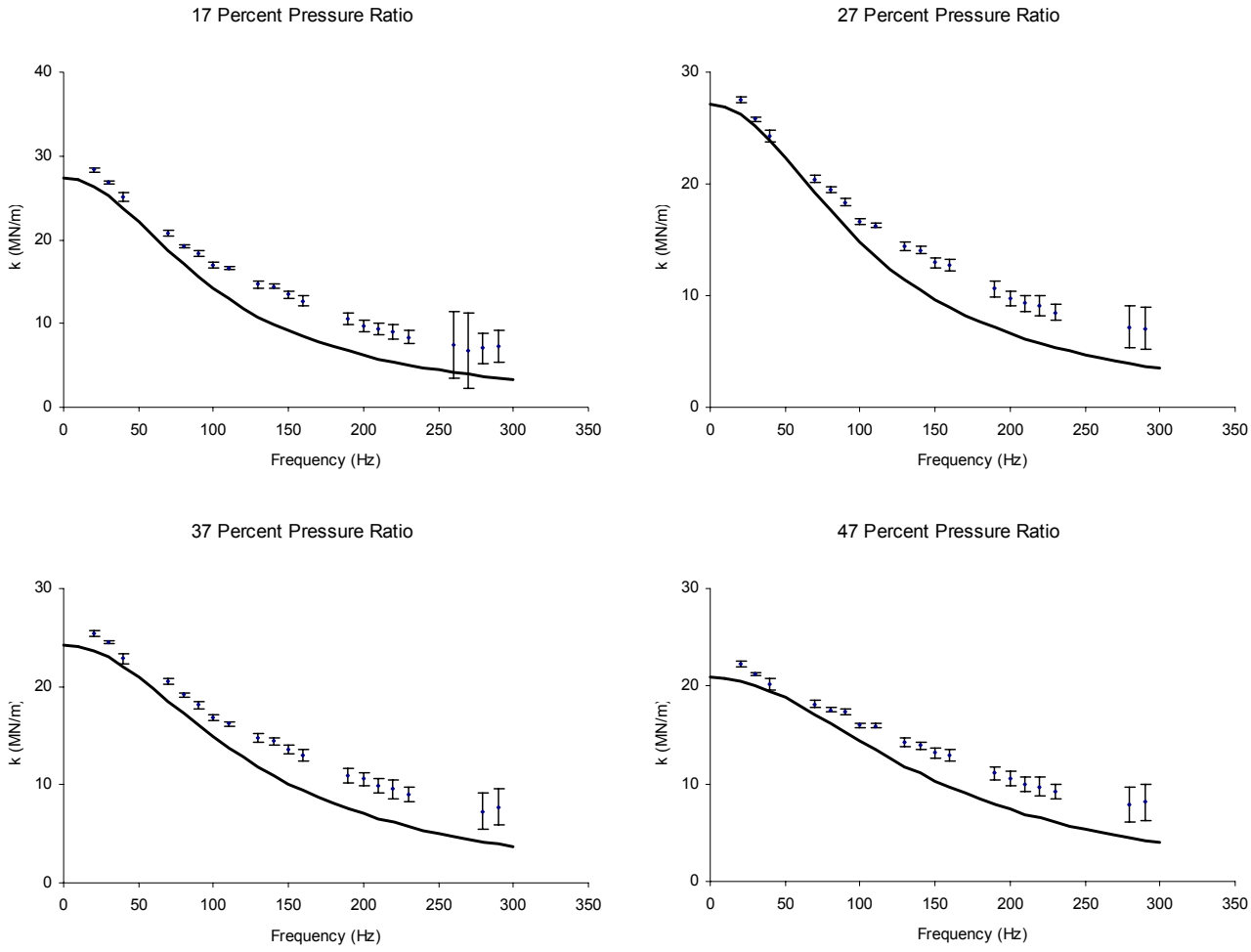

Figure 27. 0.20 mm data cross-coupled stiffness coefficients for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200\,RPM$

Figure 28 illustrates how well the code compensates for changes in inlet fluid preswirl. The plots on the left-hand side of the figure are the direct stiffness plots and the ones on the right are the cross-coupled stiffness plots. The direct stiffness is slightly under predicted in all cases. Changes in preswirl do not have a strong affect on the prediction of the direct stiffness for the 0.10 mm (4 mils) radial clearance data. Also, the cross-coupled data are predicted well for all three inlet preswirls.

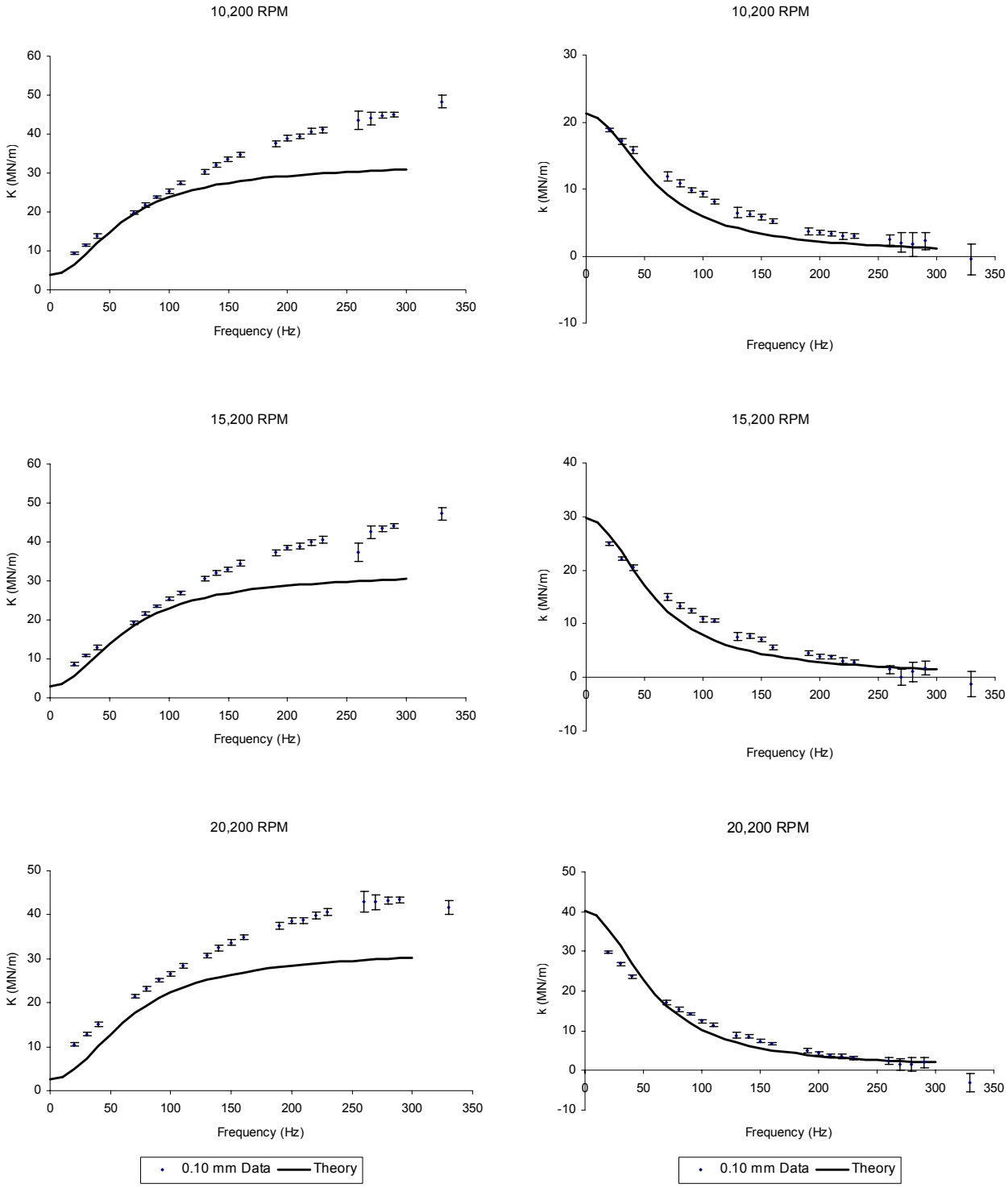

Figure 28. 0.10 mm data direct and cross-coupled stiffnesses coefficients for all preswirls, $PR = 47\%$, $\omega = 20{,}200 RPM$

Figure 29 again shows how well the code can predict the affect of the inlet preswirl on the direct and cross-coupled stiffnesses, with the larger clearance. The inlet preswirl does have a small effect on the direct stiffness prediction, which is representative of the rest of the results. There is less error in the predictions as the inlet preswirl increases. Also, predictions for the cross-coupled stiffnesses become better as the preswirl increases. But, both the direct and cross-coupled stiffnesses are still under predicted.

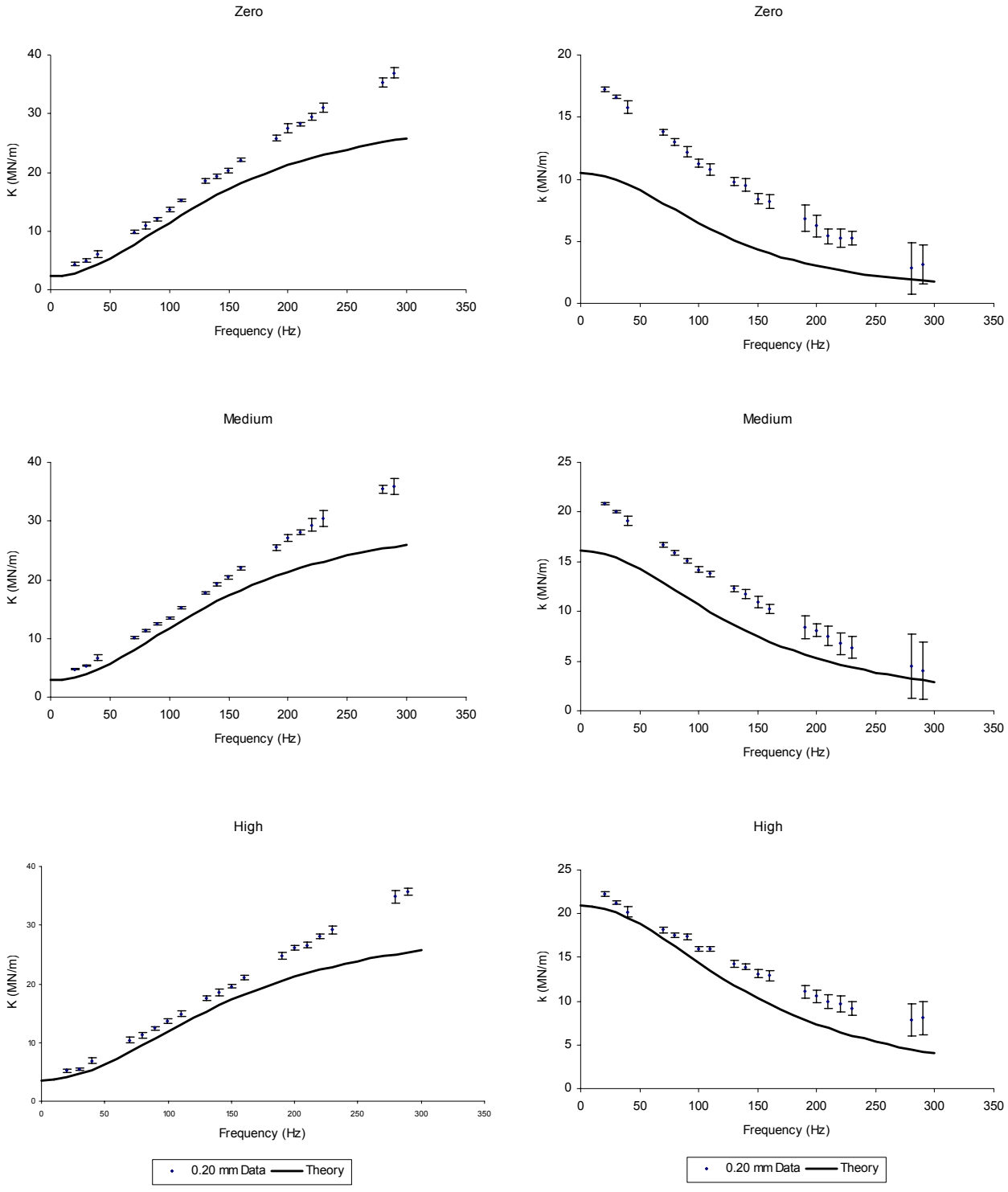

Figure 29. 0.20 mm data direct and cross-coupled stiffnesses coefficients for all preswirls, $PR = 47\%$, $\omega = 20{,}200\,RPM$

Figure 30 shows the effect of the rotor speed on the prediction of the direct and cross-coupled stiffnesses. The direct stiffness is predicted better at the lower speeds. Also, the cross-coupled stiffness does not show a noticeable difference in the accuracy of prediction based on the rotor speed. The data presented were recorded with the smaller clearance, the high preswirl, and a pressure ratio of 47 percent.

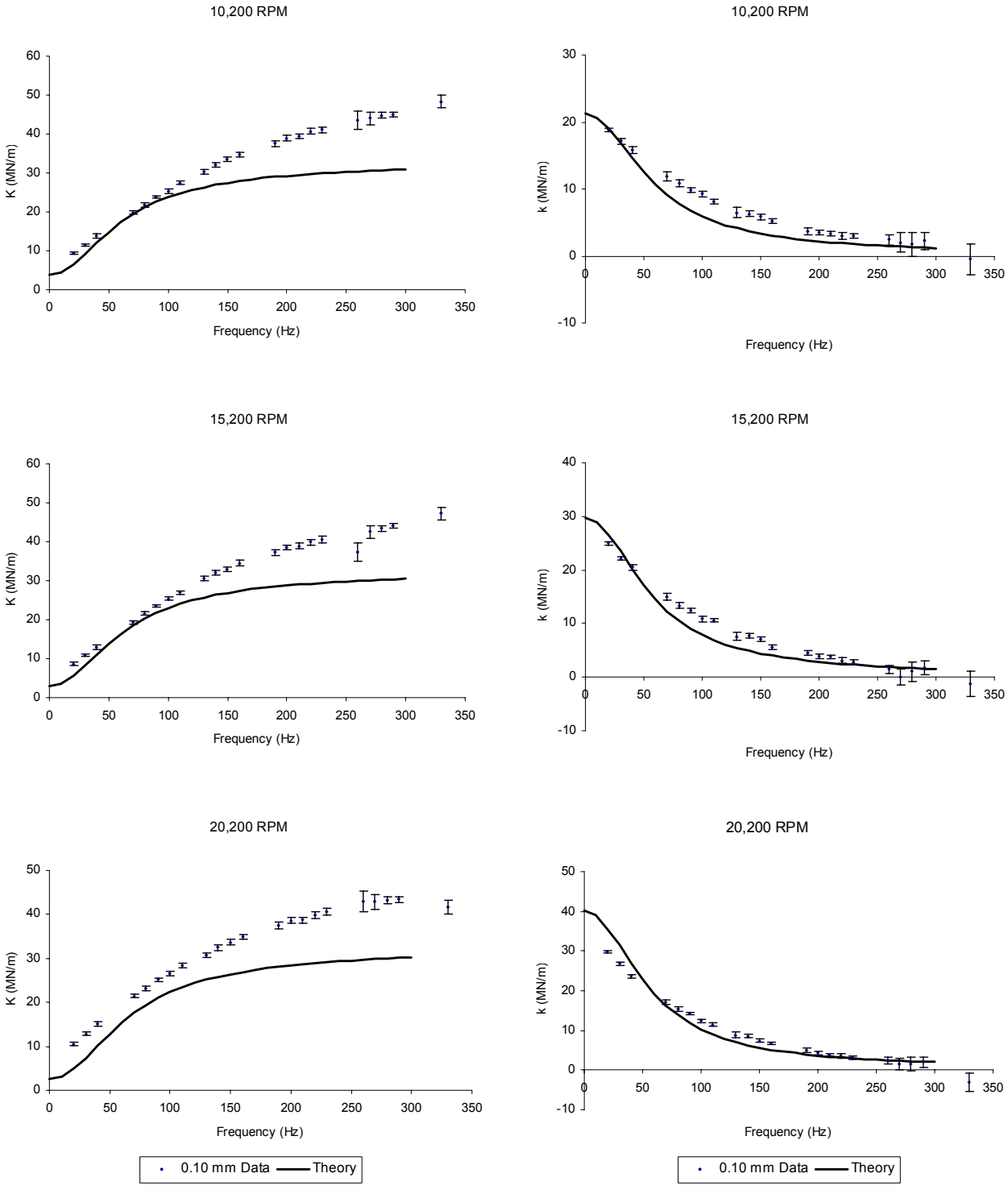

Figure 30. 0.10 mm data direct and cross-coupled stiffness coefficients for different rotor speeds with the high inlet preswirl and $PR = 47\%$

Figure 31 shows the accuracy of the predicted direct and cross-coupled stiffness predictions for the larger clearance. The data presented were recorded under the high preswirl condition and a pressure ratio of 47 percent. Note again that the direct stiffness is predicted marginally better at the lower rotor speeds. Also, the accuracy of cross-coupled stiffness predictions are not significantly affected by the rotor speed in all three rotor speeds; the cross-coupled stiffness is predicted well.

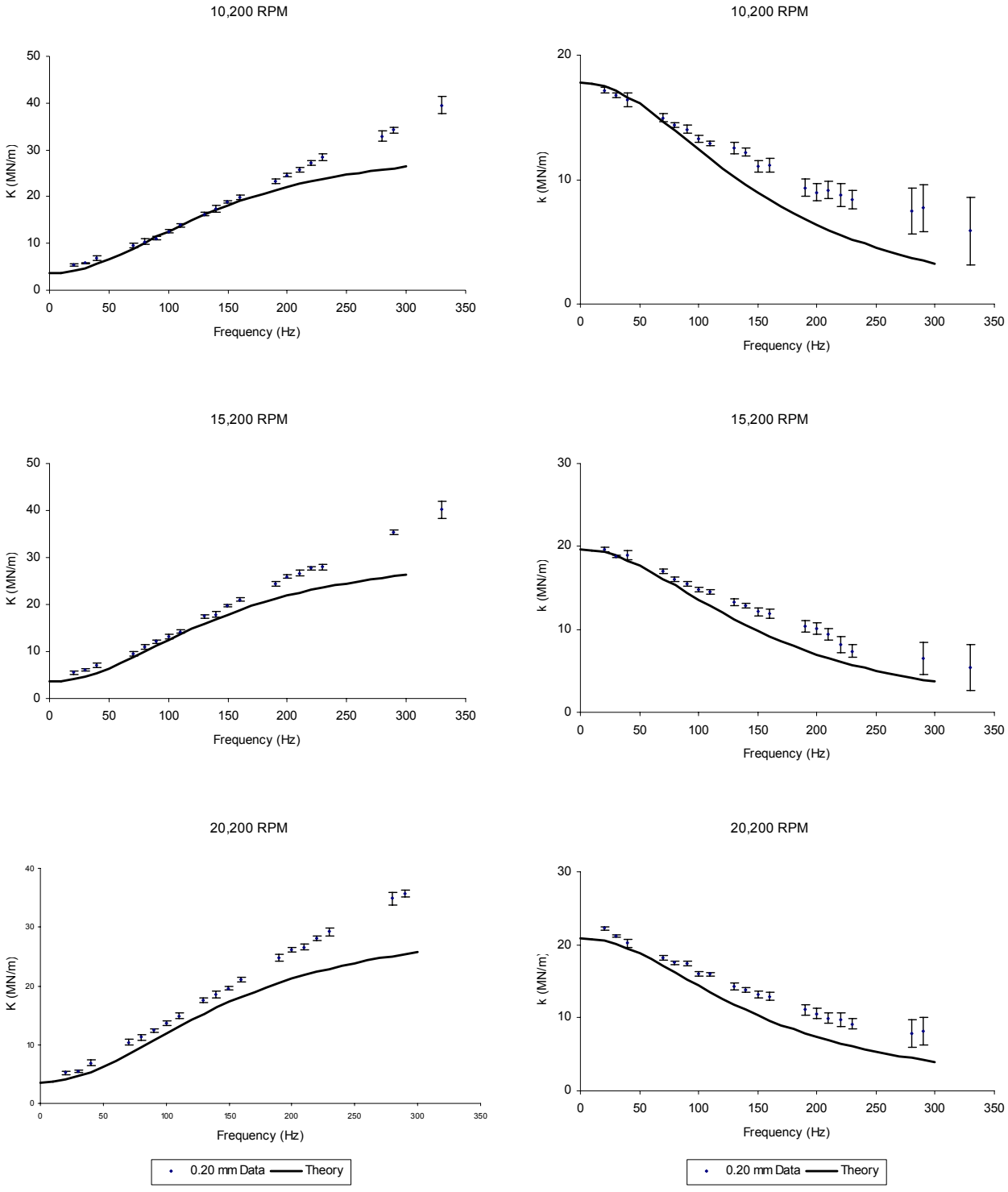

Figure 31. 0.20 mm data direct and cross-coupled stiffness coefficients for different rotor speeds with the high inlet preswirl and $PR = 47\%$

Direct and cross-coupled damping

Figure 32 shows the direct damping measured for the smaller clearance with the high inlet preswirl and a rotor speed of 20,200 RPM. As can be seen, direct damping is predicted better at the lower frequencies for the higher pressure ratios. But above

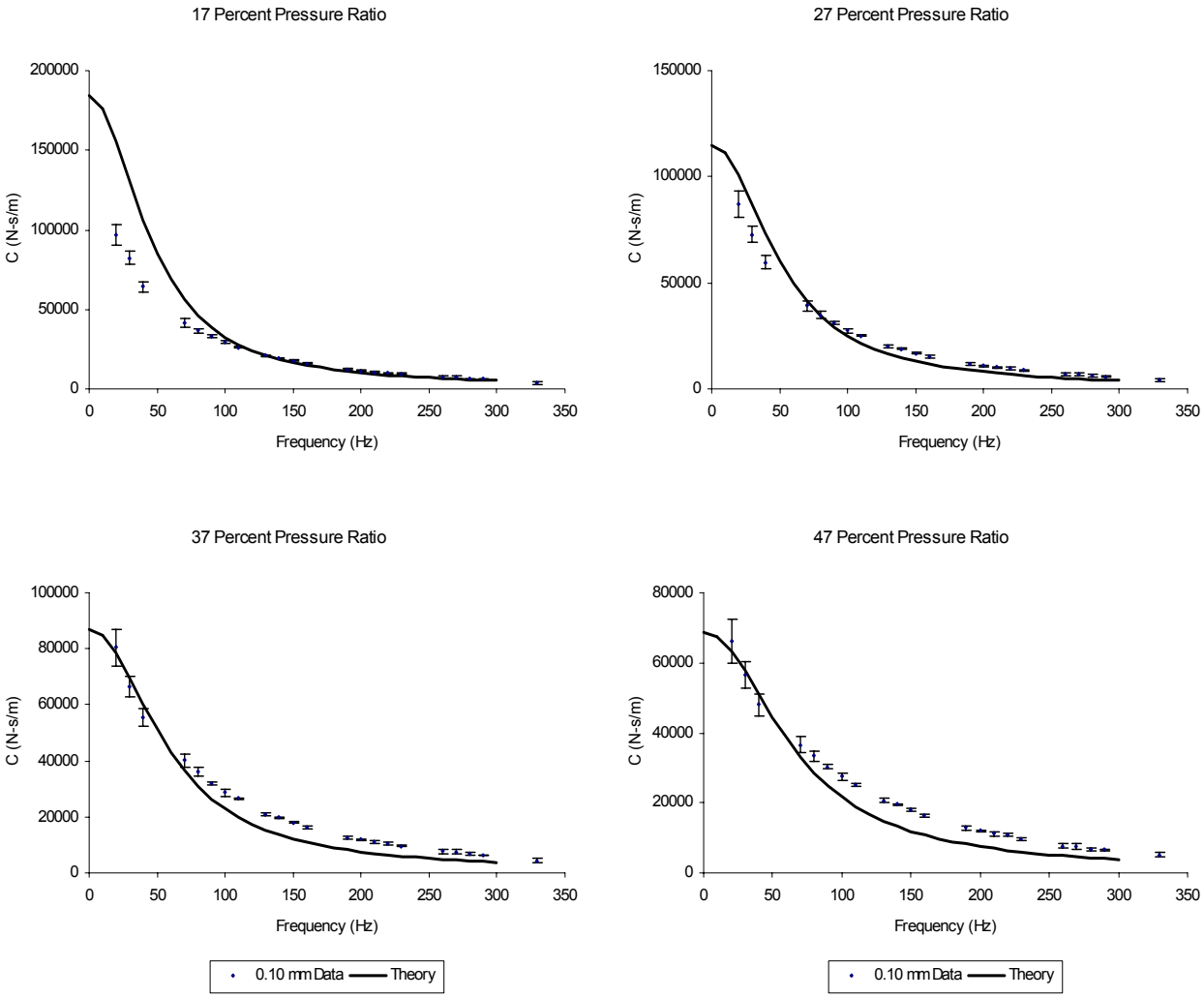

Figure 32. 0.10 mm direct damping coefficients for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200 RPM$

approximately 100 Hz, they are predicted better at the lower pressure ratios. For lower pressure ratios, the direct damping is predicted better at the higher frequencies, and at the higher pressure ratios the lower frequencies are predicted better.

Figure 33 shows the cross-coupled damping coefficients for the smaller clearance, the high preswirl, and the rotor speed was 20,200 RPM. The cross-coupled damping is predicted well at all pressure ratios. The accuracy of the predicted cross-coupled damping does not appear to be function of the pressure ratio.

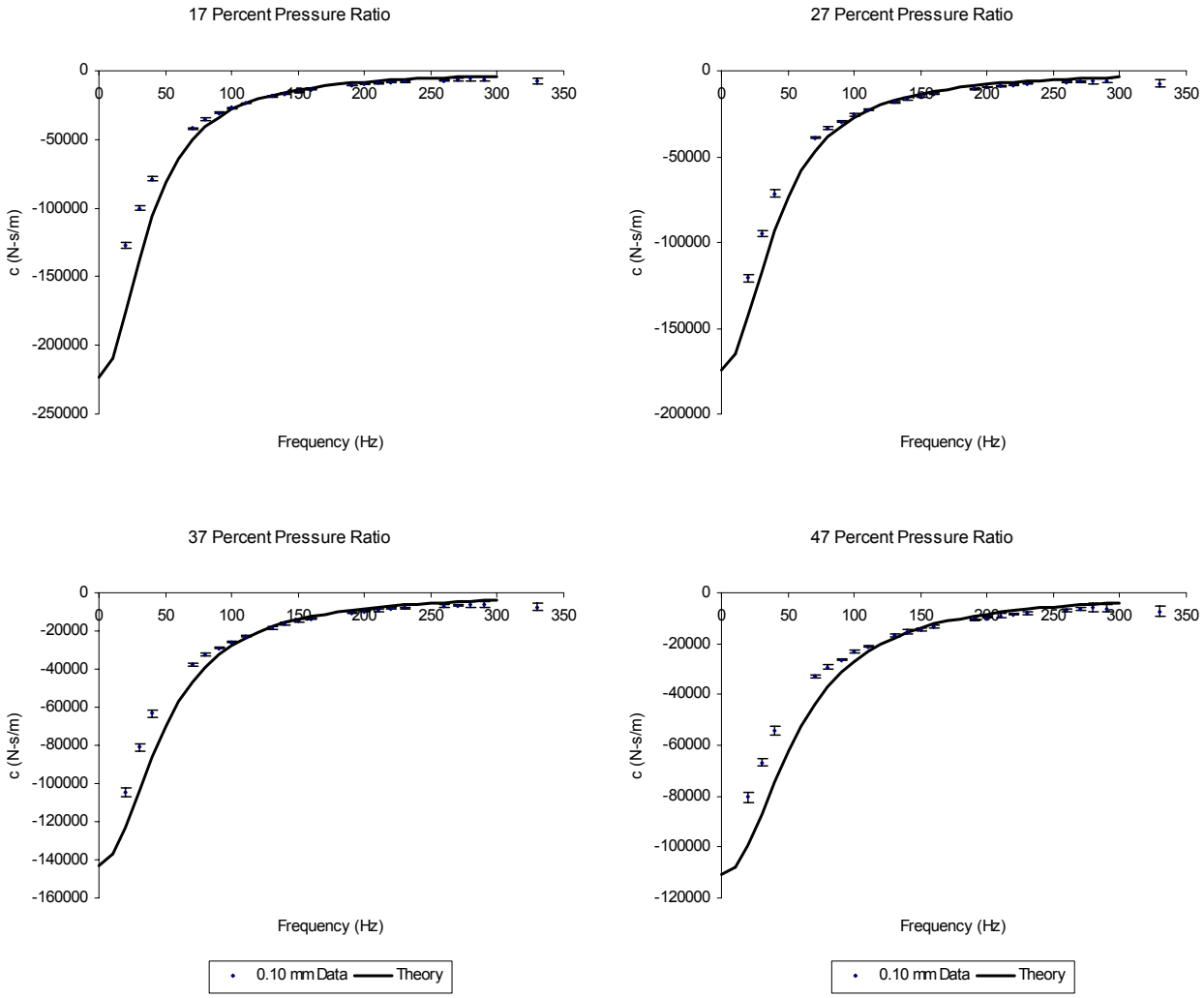

Figure 33. 0.10 mm data cross-coupled damping coefficients for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200 RPM$

Figure 34 shows the direct damping for the larger clearance with the high inlet preswirl at the highest rotor speed. The damping is predicted well for all conditions, but the accuracy is better for the data at the lower pressure ratios.

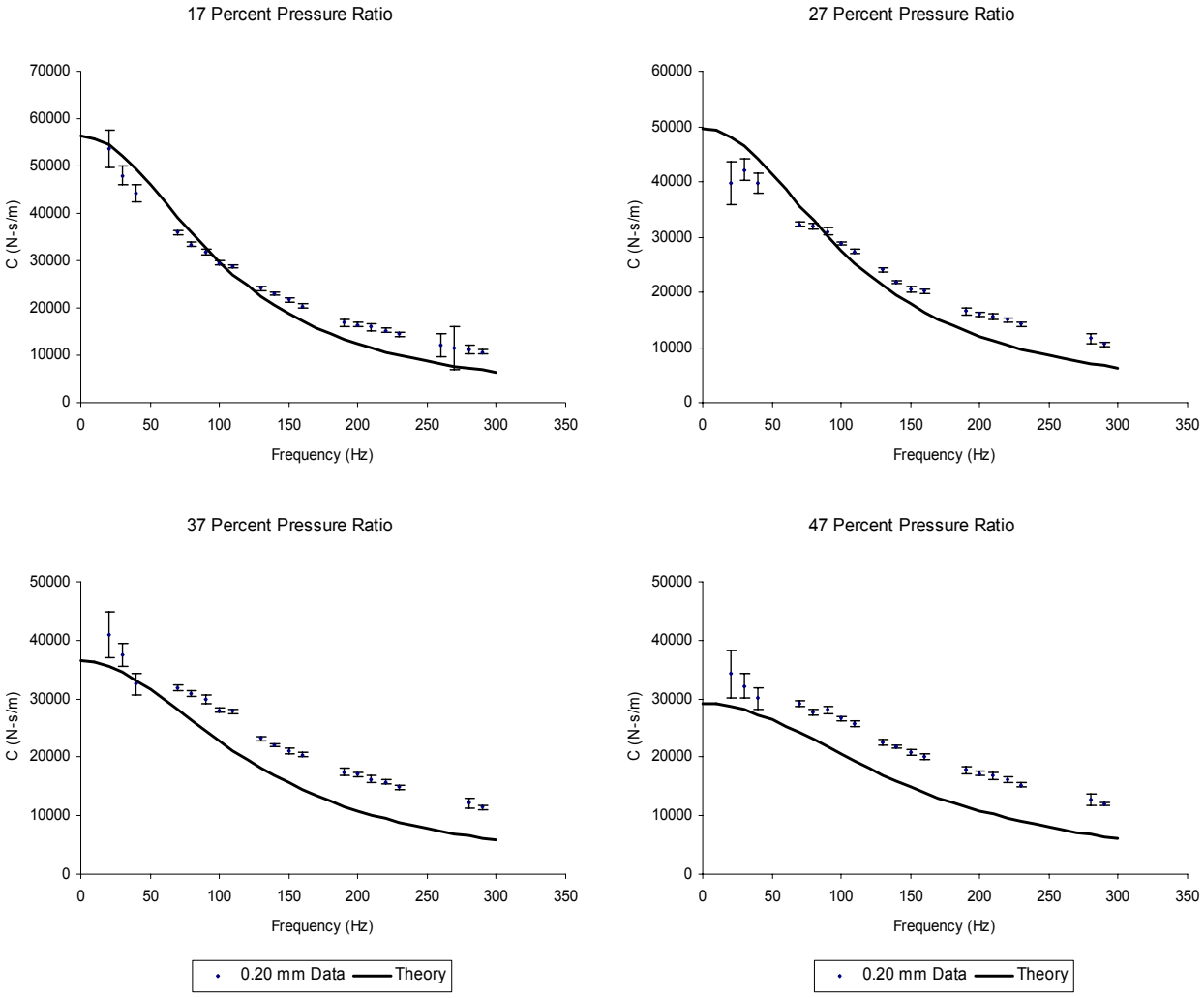

Figure 34. 0.20 mm direct damping coefficients for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200\,RPM$

Figure 35 shows the cross-coupled damping with the larger clearance, high preswirl, and a rotor speed of 20,200 RPM. The prediction accuracy of the cross-coupled damping is not significantly affected by the pressure ratio. The cross-coupled

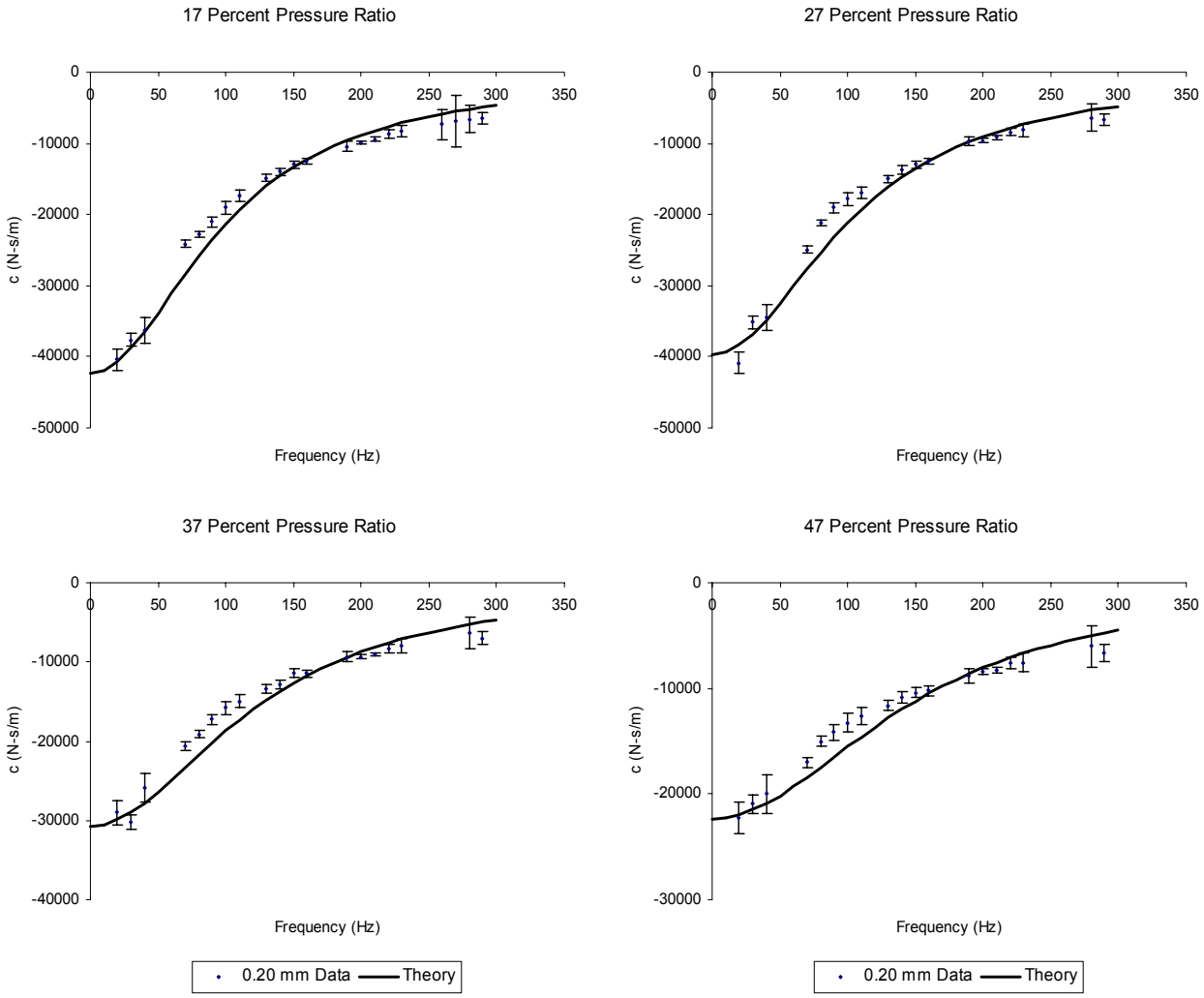

Figure 35. 0.20 mm data cross-coupled damping coefficients for different pressure ratios with the high inlet preswirl and $\omega = 20{,}200 RPM$

damping is predicted very well for all pressure ratios. The direct and cross-coupled damping coefficients are both generally predicted very for both clearances.

Figure 36 presents the direct and cross-coupled damping for different preswirls. The coefficients are predicted well for all conditions. The accuracy of the direct and cross-coupled damping is not greatly affected by the inlet fluid preswirl. The test data in Figure 36 were measured with a pressure ratio of 47 percent and a rotor speed of 20,200 RPM, at the smaller clearance.

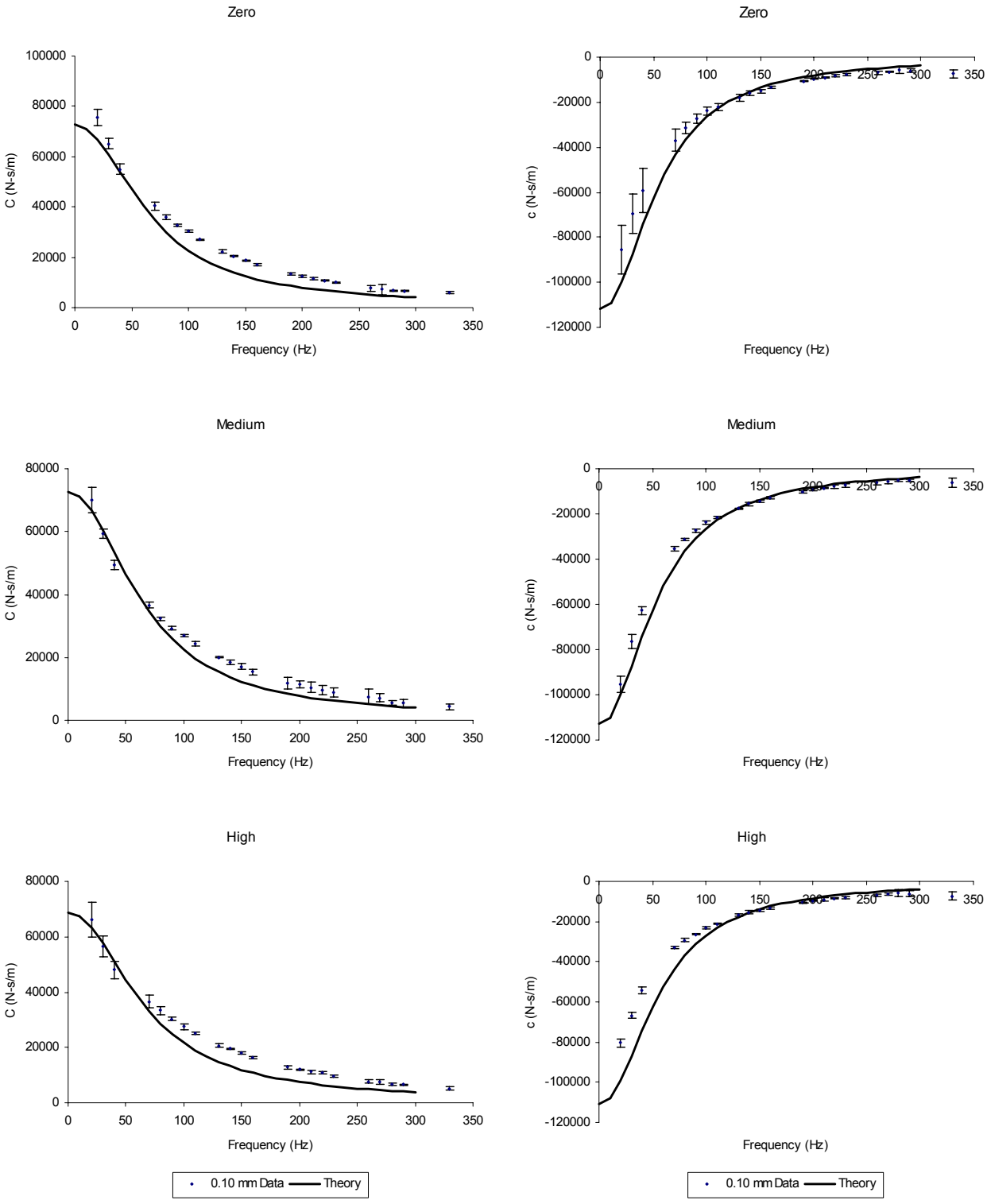

Figure 36. 0.10 mm data direct and cross-coupled damping coefficients for all preswirls, $PR = 47\%$, $\omega = 20{,}200 RPM$

Figure 37 presents the direct and cross-coupled damping for different fluid preswirls at the larger clearance. The coefficient predictions are acceptable for all tested conditions. The accuracy of the direct damping is not greatly affected by the inlet fluid preswirl. The accuracy of the predicted cross-coupled damping increases with increasing fluid preswirl. The test data were measured with a pressure ratio of 47 percent and a rotor speed of 20,200 RPM.

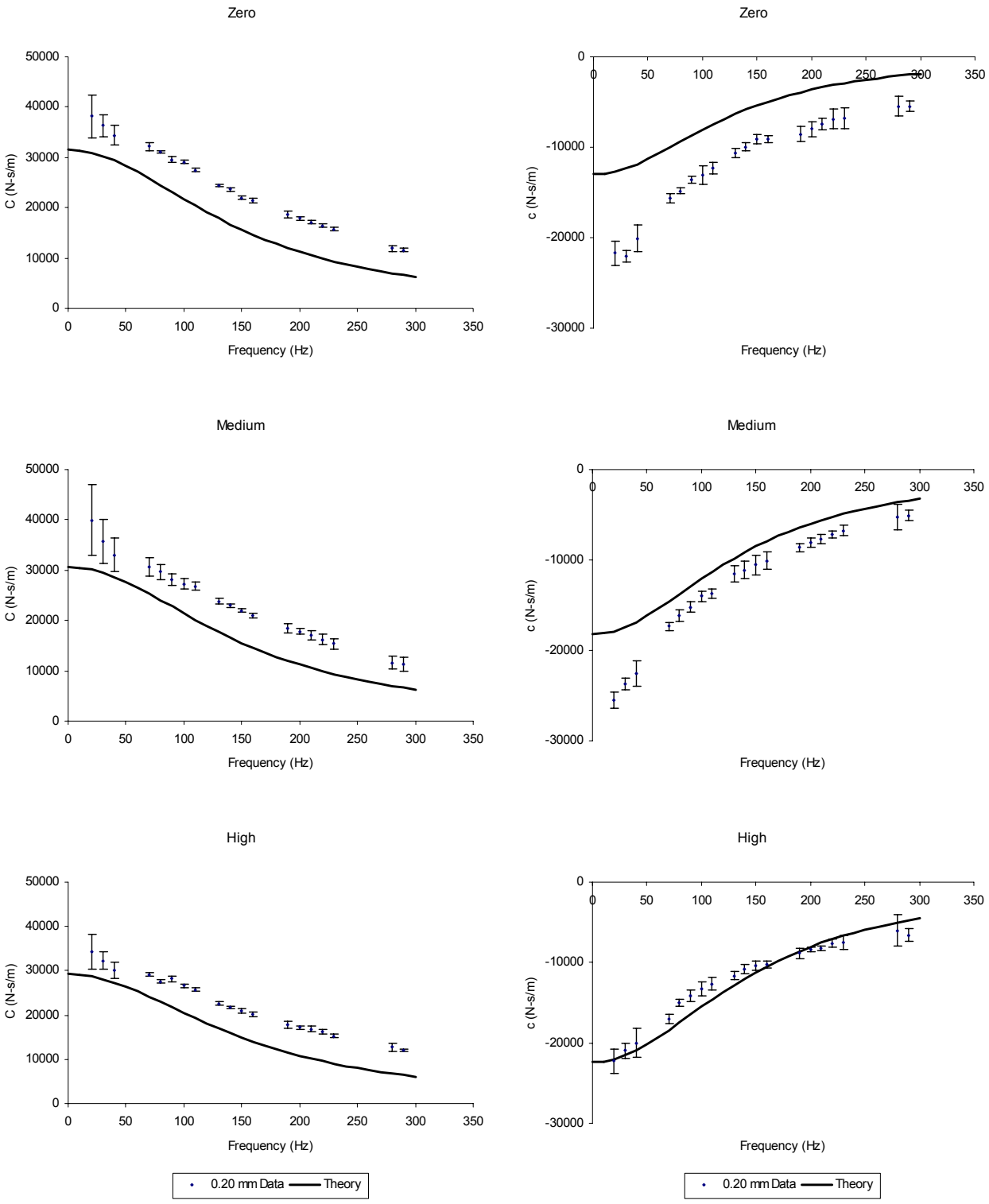

Figure 37. 0.20 mm data direct and cross-coupled damping coefficients for all preswirls, $PR = 47\%$, $\omega = 20{,}200\,RPM$

Figure 38 shows the influence of running speed on predictions of direct and cross-coupled damping coefficients. Prediction accuracies of both the direct and cross-coupled damping are not significantly affected by different rotor speeds. The data were measured with the smaller clearance, a pressure ratio of 47 percent, and high fluid preswirl. Direct and cross-coupled damping were predicted well for all conditions. The predictions for the smaller clearance tests tend to be slightly more accurate than the predictions for the larger clearance tests.

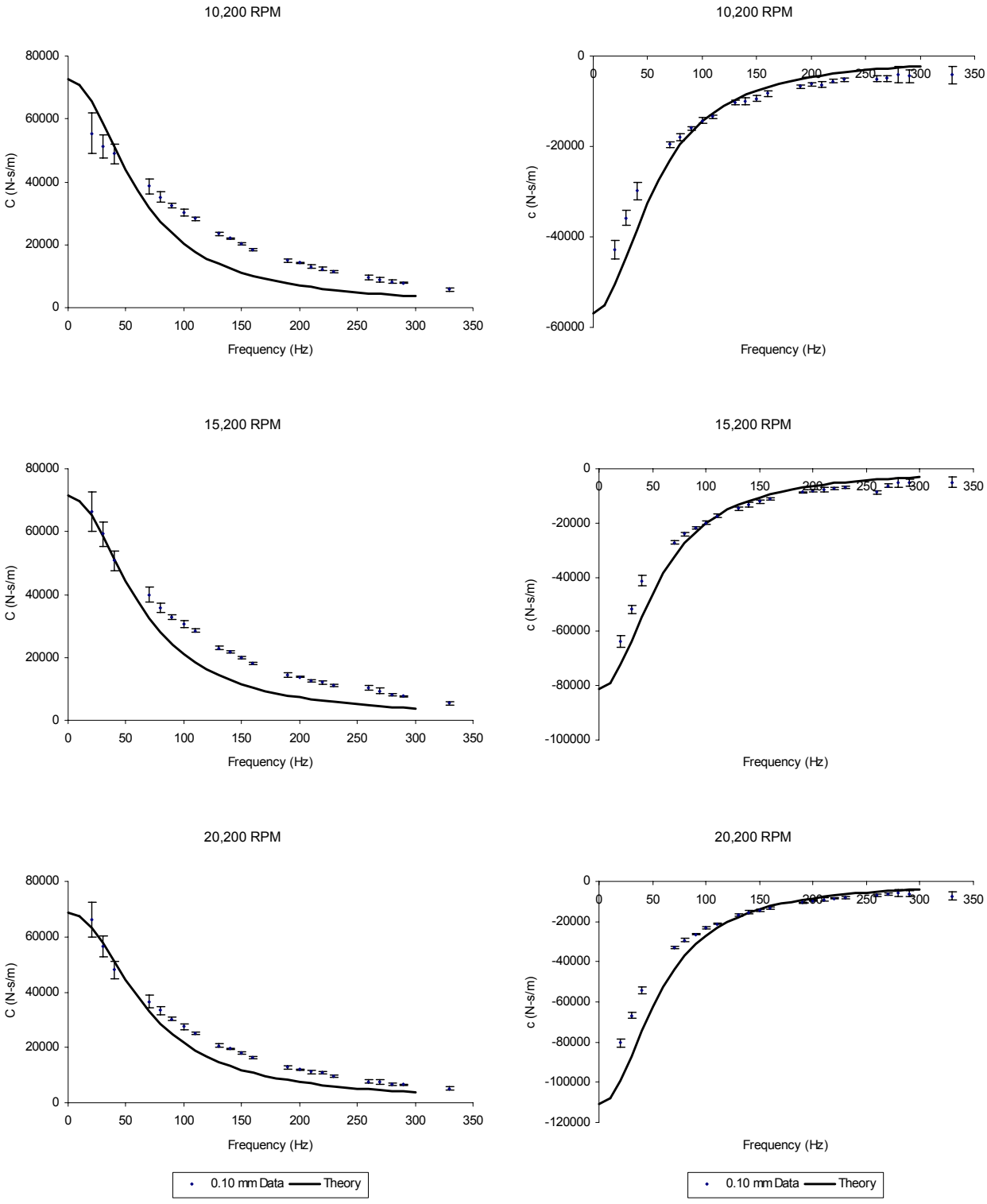

Figure 38. 0.10 mm data direct and cross-coupled damping coefficients for different rotor speeds with the high inlet preswirl and $PR = 47\%$

Figure 39 shows how the accuracy of the direct and cross-coupled damping is affected by the rotor speed. The predictions of both the direct and crow-coupled damping show slight increases in accuracy as the rotor speed increases. Although the direct and cross-coupled damping is predicted well for all conditions tested. The data presented was measured with the larger clearance, a pressure ratio of 47 percent, and high fluid preswirl.

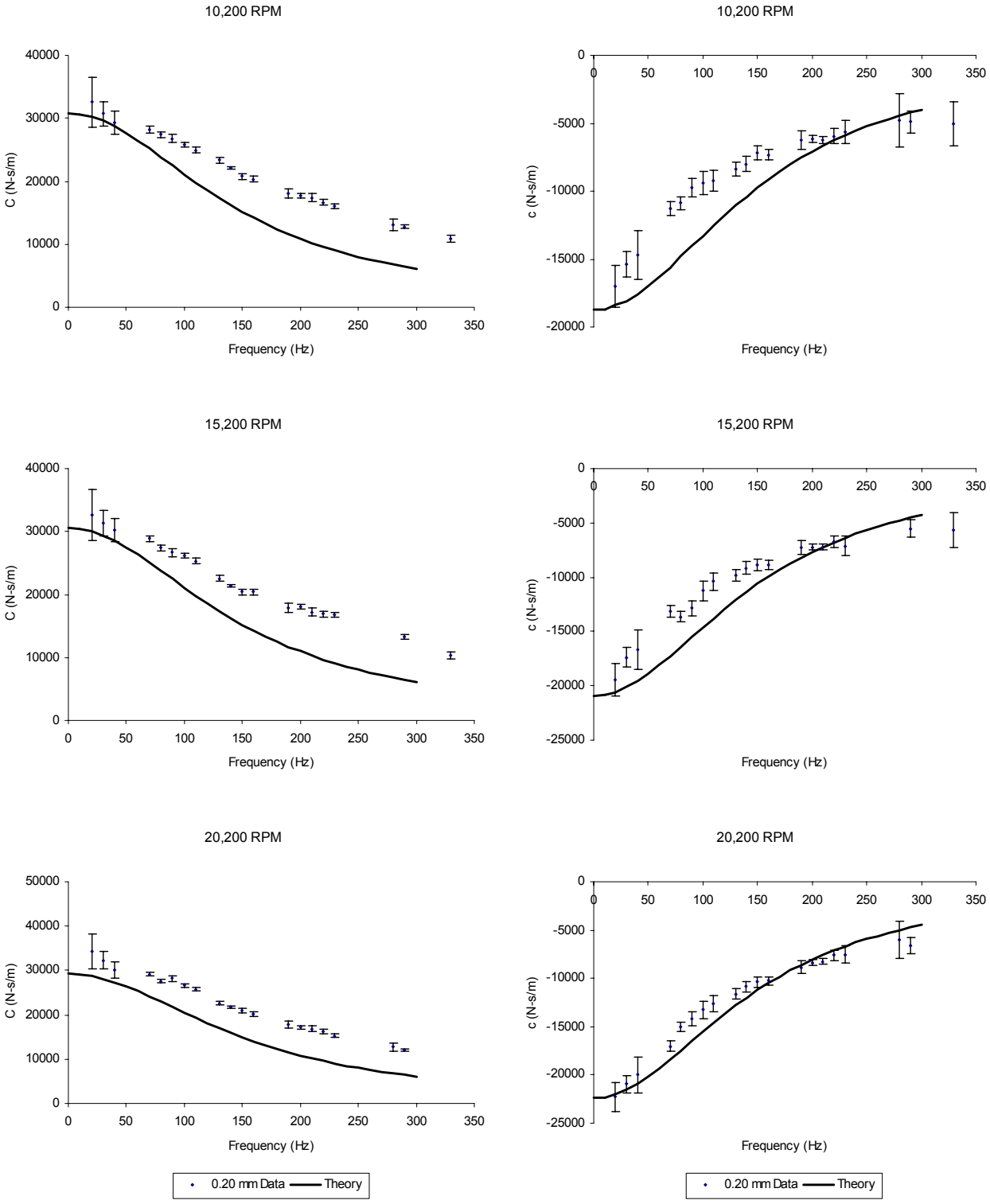

Figure 39. 0.20 mm data direct and cross-coupled damping coefficients for different rotor speeds with the high inlet preswirl and $PR = 47\%$

Seal leakage

Figure 40 shows the trends that are observed in the seal leakage data and the accuracy of ISOTSEAL in predicting the leakage. Figure 40 shows that the 0.10 mm (4 mils) data, the leakage is slightly under predicted and with the 0.20 mm (8 mils) data, the leakage is slightly over predicted. The data presented in Figure 40 were recorded with a rotor speed of 10,200 RPM. At the smaller pressure drops, the mass flow generally increases with increasing pressure drop and then levels off as the pressure drop increases more. The leakage levels off because the seals become choked at the largest pressure drop across the test seals (17% pressure ratio).

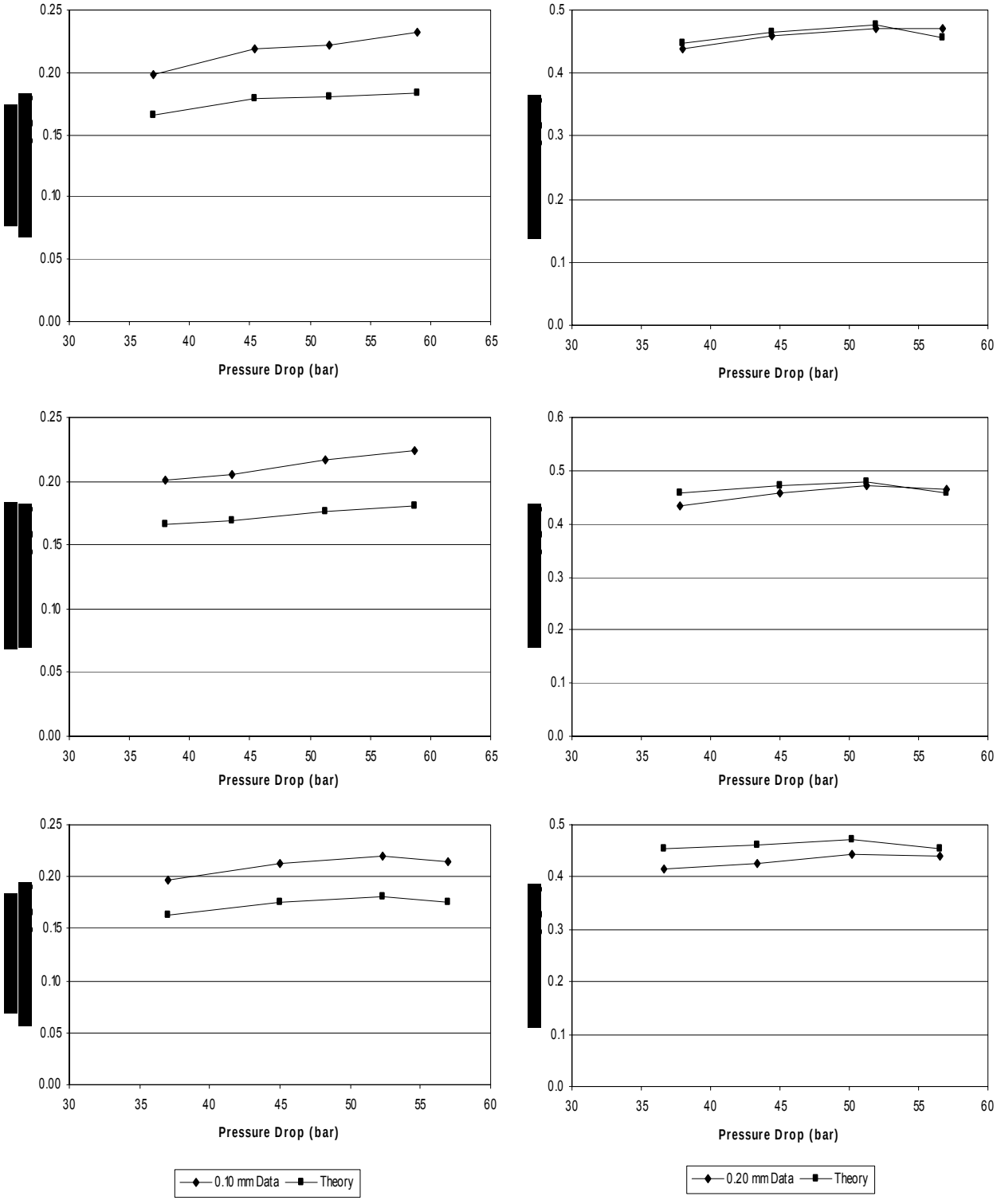

Figure 40. Seal leakage measurements and predictions $\omega = 10{,}200 RPM$

SUMMARY AND CONCLUSIONS

The testing sequence presented in this thesis was established to determine the sensitivity of the rotordynamic coefficients and leakage of hole-pattern seals to changes in the testing parameters: pressure ratio, inlet fluid preswirl, rotor speed, and radial clearance.

The rotordynamic coefficients showed little effect resulting from the different pressure ratios tested. Only the direct and cross-coupled damping coefficients of the large clearance data showed some influence at the lower frequencies. One other notable result from the testing of different pressure ratios is that the seals were tested in a choked flow condition, and there was not a significant change in the seal behavior when the seals transitioned to the choked condition.

The inlet fluid preswirl only had a notable affect on the cross-coupled stiffness in the larger clearance tests. This leads to the conclusion that a swirl brake could have some rotordynamic value, but only if the seals have sufficiently large clearances. Conversely if hole-pattern seals are being implemented with a small clearance then the use of a swirl brake would not be an effective way to improve the rotordynamic stability of the system.

The only real effect that the changes in the rotor speed had were that the cross-coupled coefficients increased as the rotor speed increased. This is the expected result because as the rotor speed increases there is a greater shear force on the gas as it passes through the seal resulting in higher fluid circumferential velocity, which results in stronger cross-coupled coefficients.

The changes in clearance resulted in drastic changes in the magnitude of the coefficients; the smaller clearance resulted in much higher coefficients.

All of the rotordynamic coefficients were predicted well by ISOTSEAL. The code was found to do a good job predicting the seal leakage as well.

REFERENCES

1. Childs, D., and Moyer, D., 1985, “Vibration Characteristics of the HPOTP (High Pressure Oxygen Turbopump) of the SSME (Space Shuttle Main Engine),” ASME Trans., Journal of Engineering for Gas Turbine and Power, **107**, pp. 152-159.
2. Sprowl, T., 2003, “A Study of the Effects of Inlet Preswirl on the Dynamic Coefficients of a Straight-Bore Honeycomb Gas Damper Seal,” MS Thesis, Department of Mechanical Engineering. Texas A&M University, College Station.
3. Wachter, J., and Benkert, H., 1980, “Flow Induced Spring Coefficients of Labyrinth Seal for Applications in Rotordynamics,” **Proceedings of the Rotordynamic Instability Problems in High-Performance Turbomachinery Workshop**, Texas A&M University, NASA CP-2133, pp. 189-212.
4. Childs, D., Elrod, D., and Hale, K., 1989, “Annular Honeycomb Seals: Test Results for Leakage and Rotordynamic Coefficients; Comparison to Labyrinth and Smooth Configurations,” ASME Journal of Tribology, **111**, pp. 293-301.
5. Yu, Z., and Childs, D., 1998, “A Comparison of Experimental Rotordynamic Coefficients and Leakage Characteristics Between Hole-Pattern Gas Damper Seals and a Honeycomb Seal,” Journal of Engineering for Gas Turbines and Power, **120** pp. 778-783.
6. Dawson, M., 2000, “A Comparison of the Static and Dynamic Characteristics of Straight-Bore and Convergent Tapered-Bore Honeycomb Annular Gas Seals,” MS Thesis, Department of Mechanical Engineering. Texas A&M University, College Station.
7. Holt, C., 2001, “Rotordynamic Evaluation of Frequency Dependent Impedances of Hole-Pattern Gas Damper Seals,” MS Thesis, Department of Mechanical Engineering. Texas A&M University, College Station.
8. Weatherwax, M., and Childs, D., 2002, “The Influence of Eccentricity Effects on the Rotordynamic Coefficients of a High-Pressure Honeycomb Annular Gas Seal, Measurements Versus Predictions,” ASME Paper 2002-TRIB-207
9. Kleynahns, G., and Childs, D., 1997, “The Acoustic Influence of Cell Depth on the Rotordynamic Characteristics of Smooth-Rotor/Honeycomb-Stator Annular Gas Seals,” ASME J. Eng. Gas Turbines Power, **4**, pp. 949-957.

10. Childs, D., and Hale, K., 1994, “A Test Apparatus and Facility to Identify the Rotordynamic Coefficients of High-Speed Hydrostatic Bearings,” ASME Journal of Tribology, **116**, pp. 337-334.
11. Dawson, M., Childs, D., Holt, C., and Phillips, S., 2002, “Theory Versus Experiments for the Dynamic Impedances of Annular Gas Seals: Part 1 – Test Facility and Apparatus,” ASME J. Eng. Gas Turbines Power, **24**, pp. 958-963.
12. Kurtin, K. A., Childs, D. W., San Andres, L. A., and Hale, R. K., 1993, “Experimental Versus Theoretical Characteristics of a High-Speed Hybrid (Combination Hydrostatic and Hydrodynamic) Bearing,” ASME Journal of Tribology, **115**, pp. 160-169.
13. Kleynhans, G., 1996, “A Two-control-volume Bulk-flow Rotordynamic Analysis for Smooth-rotor/Honeycomb-stator Gas Annular Seals,” PhD Dissertation, Department of Mechanical Engineering. Texas A&M University, College Station.
14. Childs, D., 1993, *Turbomachinery Rotordynamics – Phenomena, Modeling and Analysis*, John Wiley & Sons, New York.

APPENDIX A

Table 4. 0.10 mm high preswirl $PR = 17\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties						
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}
20	3.87	10.24	22.12	-8.58	-23.67	9.24	4.40	10.38	0.269	0.223	0.372	0.192	0.527	0.280	0.324
30	7.28	13.01	18.95	-10.77	-20.42	10.44	6.89	13.33	0.257	0.243	0.334	0.204	0.472	0.252	0.325
40	9.80	14.24	15.99	-11.22	-18.02	11.72	10.31	15.57	0.454	0.402	0.352	0.268	0.403	0.384	0.402
70	17.51	17.30	11.04	-11.18	-12.53	11.20	17.24	18.14	0.253	0.321	0.388	0.273	0.459	0.279	0.589
80	19.36	18.18	10.02	-11.13	-10.56	11.25	19.70	18.58	0.505	0.411	0.349	0.329	0.340	0.312	0.503
90	21.20	18.91	9.11	-10.79	-9.74	10.33	21.27	19.20	0.369	0.328	0.245	0.135	0.254	0.187	0.271
100	23.42	18.92	7.97	-10.86	-8.83	10.16	23.17	18.99	0.440	0.378	0.314	0.217	0.278	0.342	0.548
110	24.85	19.06	7.52	-10.17	-7.86	10.25	25.50	18.98	0.391	0.349	0.291	0.195	0.206	0.254	0.480
130	27.49	18.31	5.58	-9.78	-6.59	10.00	28.23	18.94	0.434	0.407	0.311	0.182	0.256	0.304	0.605
140	29.06	17.90	5.15	-9.59	-6.54	9.46	29.59	18.70	0.497	0.371	0.202	0.237	0.228	0.347	0.610
150	30.55	18.07	4.71	-9.28	-5.90	9.09	30.75	17.72	0.472	0.399	0.185	0.077	0.226	0.304	0.610
160	31.20	17.13	4.19	-8.59	-5.42	9.09	31.92	17.09	0.529	0.360	0.272	0.122	0.129	0.258	0.618
190	33.74	16.02	2.86	-7.83	-4.60	8.26	34.28	15.99	0.522	0.344	0.156	0.173	0.195	0.271	0.644
200	34.53	16.00	2.79	-7.17	-4.00	8.83	35.07	15.82	0.632	0.380	0.188	0.186	0.144	0.260	0.654
210	34.82	15.43	2.55	-7.02	-3.43	9.21	35.73	15.46	0.627	0.366	0.127	0.167	0.164	0.269	0.644
220	36.25	15.64	2.42	-6.80	-2.90	8.64	36.14	15.07	0.626	0.367	0.134	0.150	0.171	0.255	0.645
230	36.84	14.76	2.28	-6.54	-3.10	8.35	36.63	14.77	0.674	0.322	0.131	0.182	0.157	0.209	0.678
260	39.05	13.51	0.77	-5.39	-3.62	9.94	38.26	12.71	0.769	0.548	0.571	0.590	0.456	0.531	1.048
270	39.21	12.70	1.45	-4.58	-2.38	10.51	37.49	13.09	0.619	0.412	0.409	0.437	0.257	0.289	0.725
280	39.94	12.28	1.55	-4.13	-2.10	10.97	38.38	13.18	0.628	0.409	0.307	0.287	0.170	0.293	0.622
290	40.03	11.73	1.78	-4.82	-2.26	11.18	39.42	13.51	0.693	0.335	0.195	0.295	0.128	0.220	0.635
330	39.66	8.98	0.17	-3.08	3.18	14.82	42.52	9.87	0.712	0.342	0.333	0.257	0.296	0.460	0.645

Table 5. 0.10 mm high preswirl $PR = 17\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties						
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}
20	4.65	12.21	29.73	-12.99	-31.70	13.26	4.25	11.68	0.269	0.223	0.372	0.192	0.527	0.280	0.324
30	8.67	14.91	25.02	-15.02	-26.58	14.31	6.99	14.32	0.257	0.243	0.334	0.204	0.472	0.252	0.325
40	10.54	14.56	20.96	-14.99	-22.99	16.27	11.14	17.03	0.454	0.402	0.352	0.268	0.403	0.384	0.402
70	19.09	17.83	13.65	-14.69	-16.59	14.84	18.29	20.03	0.253	0.321	0.388	0.273	0.459	0.279	0.589
80	20.94	18.47	12.50	-14.28	-14.05	15.35	21.40	19.84	0.505	0.411	0.349	0.329	0.340	0.312	0.503
90	23.38	19.24	12.03	-14.86	-12.37	14.46	23.21	19.36	0.369	0.328	0.245	0.135	0.254	0.187	0.271
100	25.46	19.21	9.69	-14.50	-11.60	13.59	24.81	20.04	0.440	0.378	0.314	0.217	0.278	0.342	0.548
110	26.61	19.23	9.53	-13.84	-10.18	14.08	27.13	19.52	0.391	0.349	0.291	0.195	0.206	0.254	0.480
130	29.47	17.81	6.67	-13.06	-7.90	12.85	29.49	18.65	0.434	0.407	0.311	0.182	0.256	0.304	0.605
140	30.84	18.33	6.79	-12.64	-7.76	12.76	31.31	18.81	0.497	0.371	0.202	0.237	0.228	0.347	0.610
150	32.10	17.96	6.04	-12.32	-7.40	12.77	32.64	18.31	0.472	0.399	0.185	0.077	0.226	0.304	0.610
160	33.26	16.84	4.55	-11.79	-6.17	11.98	33.30	17.29	0.529	0.360	0.272	0.122	0.129	0.258	0.618
190	35.67	15.91	3.03	-10.33	-5.53	11.23	35.91	16.00	0.522	0.344	0.156	0.173	0.195	0.271	0.644
200	36.73	15.65	2.74	-9.77	-4.43	11.10	36.45	15.59	0.632	0.380	0.188	0.186	0.144	0.260	0.654
210	36.42	15.35	2.78	-9.07	-3.56	11.33	36.91	15.11	0.627	0.366	0.127	0.167	0.164	0.269	0.644
220	37.99	15.69	2.77	-8.87	-3.12	10.79	37.52	14.87	0.626	0.367	0.134	0.150	0.171	0.255	0.645
230	38.40	15.12	2.41	-8.87	-2.94	9.95	37.69	14.66	0.674	0.322	0.131	0.182	0.157	0.209	0.678
260	36.27	15.36	2.13	-10.77	-0.58	13.43	36.21	14.12	0.769	0.548	0.571	0.590	0.456	0.531	1.048
270	40.33	14.30	-0.03	-8.80	-0.88	11.78	38.64	14.47	0.619	0.412	0.409	0.437	0.257	0.289	0.725
280	41.22	11.99	0.22	-5.49	-1.82	12.55	40.55	13.22	0.628	0.409	0.307	0.287	0.170	0.293	0.622
290	41.39	11.52	1.61	-6.60	-1.84	12.70	40.77	13.05	0.693	0.335	0.195	0.295	0.128	0.220	0.635
330	41.08	8.95	0.27	-4.30	3.29	15.65	43.65	9.13	0.712	0.342	0.333	0.257	0.296	0.460	0.645

Table 6. 0.10 mm high preswirl $PR = 17\%$ $\omega = 20{,}200 RPM$

Test Data									Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.67	12.03	34.70	-15.20	-37.78	16.66	4.65	12.25	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	9.82	16.01	30.84	-18.54	-31.75	19.11	8.37	15.03	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	12.31	15.87	24.36	-19.19	-26.55	20.28	12.29	16.30	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	20.91	17.37	15.69	-18.19	-17.92	18.70	19.84	19.05	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	22.05	17.78	14.00	-17.26	-15.21	18.40	22.39	18.79	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	24.63	18.50	12.95	-17.27	-13.74	17.27	24.17	18.82	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	26.54	18.03	11.11	-16.87	-12.34	17.03	25.87	18.72	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	27.84	17.36	9.90	-16.14	-11.12	16.27	27.67	18.45	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.20	16.10	7.62	-15.10	-8.79	15.39	30.36	17.78	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.81	16.34	7.17	-14.76	-8.13	14.61	31.64	17.37	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	32.95	16.40	6.36	-14.41	-7.53	14.70	32.92	16.94	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	33.66	16.03	5.65	-13.81	-6.55	13.82	33.49	16.15	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	35.87	14.05	3.51	-12.37	-5.68	13.44	35.79	15.17	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	36.48	14.04	3.07	-11.51	-4.39	12.87	36.46	14.56	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	36.42	13.53	2.87	-10.86	-4.02	12.70	36.96	14.28	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	37.38	13.82	3.03	-10.50	-3.40	12.07	37.24	13.98	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	38.30	13.34	2.55	-10.54	-3.33	11.45	37.80	13.72	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	40.20	12.30	0.78	-9.13	-3.34	13.56	38.91	12.54	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	40.19	11.37	0.89	-8.52	-1.56	12.86	38.91	13.01	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	40.71	10.55	0.85	-6.87	-1.38	13.11	39.95	12.11	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	40.96	10.04	1.71	-8.04	-1.59	13.54	40.36	12.19	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	35.49	5.56	-0.70	-10.75	1.58	19.71	39.22	9.87	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 7. 0.10 mm high preswirl $PR = 27\%$ $\omega = 10{,}200 RPM$

Test Data									Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	7.84	9.01	21.64	-8.46	-22.63	8.27	8.07	8.98	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	10.72	11.57	18.65	-10.58	-19.50	9.44	10.08	11.46	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	11.96	13.20	16.08	-9.87	-17.36	10.75	12.99	13.72	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	19.04	16.77	11.17	-9.94	-12.28	10.61	20.21	17.02	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	20.97	17.38	10.10	-10.61	-10.71	10.30	21.63	17.92	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	23.18	18.38	10.00	-10.94	-9.71	10.07	23.49	18.34	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	25.48	18.36	7.97	-11.10	-9.10	9.35	25.20	18.62	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	26.76	18.70	7.70	-10.56	-8.47	9.55	27.30	18.75	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	29.86	18.28	5.97	-10.24	-6.39	9.19	30.29	17.96	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.12	18.23	5.80	-9.46	-6.42	8.84	31.78	18.10	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	32.65	17.51	4.95	-9.29	-6.07	8.68	33.03	17.69	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	33.69	17.26	4.13	-9.21	-4.94	8.43	33.78	16.82	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	35.65	15.86	2.62	-8.15	-4.77	8.45	36.62	15.83	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	37.07	15.90	2.75	-7.54	-4.22	8.48	37.29	15.57	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	37.46	15.43	2.58	-7.10	-3.64	8.54	37.72	15.04	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	38.72	15.48	2.58	-7.07	-2.93	8.64	38.39	14.53	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	39.24	14.24	2.14	-6.64	-3.22	8.35	38.75	14.20	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	41.57	13.54	0.84	-5.62	-3.95	9.71	40.34	12.78	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	41.70	12.18	1.22	-4.56	-2.54	10.46	39.68	12.80	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	42.10	11.91	1.97	-4.48	-2.16	10.79	40.62	13.14	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	42.68	11.31	1.76	-5.26	-2.61	10.83	41.94	13.12	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	42.22	8.55	-0.32	-3.64	2.99	15.19	45.46	10.04	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 8. 0.10 mm high preswirl $PR = 27\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.84	10.96	28.13	-11.14	-30.31	11.68	6.06	11.10	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	9.85	13.60	24.46	-13.86	-25.81	13.27	8.71	13.31	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	11.04	13.42	20.64	-13.71	-21.08	15.32	12.47	15.23	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	19.44	16.89	13.76	-13.78	-15.85	14.00	19.16	18.66	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	21.24	17.55	12.40	-13.65	-13.36	14.26	21.77	18.22	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	23.54	18.04	11.59	-14.23	-11.88	13.68	23.39	18.30	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	25.39	18.03	9.58	-13.76	-11.24	12.91	25.03	19.14	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	26.74	18.12	9.30	-13.29	-9.84	12.79	27.09	18.36	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	29.71	16.67	6.55	-12.83	-7.71	12.35	29.95	17.95	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.13	17.16	6.91	-12.33	-7.47	12.23	31.50	17.60	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	32.31	16.89	5.67	-11.95	-6.80	11.77	32.58	16.90	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	32.99	16.12	4.38	-11.65	-5.97	11.44	33.27	16.61	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	35.24	15.34	3.01	-10.33	-4.60	10.85	36.04	15.15	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	36.43	15.12	3.12	-9.58	-4.24	10.75	36.76	14.70	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	36.60	14.39	2.59	-9.13	-3.47	10.89	37.11	14.28	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	37.90	14.88	2.49	-8.88	-2.83	10.59	37.51	13.95	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	38.55	13.90	2.23	-9.00	-2.64	10.30	37.80	13.45	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	36.54	14.85	2.02	-10.94	-0.60	12.02	36.39	13.47	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	41.22	13.82	-0.32	-8.88	-0.89	11.41	38.58	13.28	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	41.63	10.92	0.50	-6.21	-1.66	12.08	40.43	12.59	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	41.19	10.58	1.23	-7.07	-1.73	12.32	40.70	12.11	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	40.96	7.77	-0.91	-4.89	2.86	15.70	44.32	8.67	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 9. 0.10 mm high preswirl $PR = 27\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.63	10.86	33.15	-14.54	-35.72	15.76	5.94	11.01	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	11.34	13.71	28.70	-17.84	-30.27	17.97	9.54	13.69	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	12.21	14.09	23.65	-17.10	-26.28	18.76	12.98	15.85	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	20.32	16.14	15.00	-16.60	-17.90	17.70	20.32	18.36	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	22.10	16.67	13.54	-16.18	-15.46	17.26	22.25	18.33	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	24.48	17.34	13.06	-16.65	-13.39	16.85	24.71	17.66	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	26.22	16.81	10.51	-16.26	-11.73	16.15	25.55	17.71	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	27.59	17.18	10.63	-15.73	-10.88	15.74	27.96	17.50	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.16	15.29	7.16	-14.80	-8.57	14.78	30.11	17.08	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.17	16.12	7.80	-14.17	-8.11	14.24	31.78	16.90	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	31.95	15.63	6.78	-13.68	-7.11	13.99	32.93	16.25	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	33.21	15.09	5.38	-13.74	-6.30	13.40	33.29	15.39	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	34.94	13.32	3.22	-12.32	-5.02	12.95	35.75	14.29	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	35.93	13.74	3.12	-11.30	-4.15	12.30	36.22	13.75	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	36.15	13.17	2.94	-10.76	-3.65	12.51	36.87	13.56	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	37.41	13.61	2.93	-10.55	-3.10	12.09	37.44	13.42	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	37.94	12.51	2.27	-10.45	-3.05	11.30	37.75	12.97	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	40.02	11.39	1.16	-8.81	-3.48	12.91	38.73	11.80	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	40.23	10.37	0.70	-8.50	-0.99	12.89	39.01	12.60	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	40.35	10.11	1.22	-7.47	-1.43	12.93	40.42	11.36	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	40.78	9.46	1.39	-8.20	-1.23	13.07	40.62	11.45	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	34.27	5.98	-2.80	-9.87	2.42	20.88	42.41	10.62	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 10. 0.10 mm high preswirl $PR = 37\%$ $\omega = 10{,}200 RPM$

Test Data									Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	8.49	8.41	21.01	-6.65	-20.99	7.08	8.86	8.30	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	11.05	11.12	18.70	-8.86	-18.59	8.13	10.51	10.89	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	13.39	12.94	16.36	-9.58	-16.48	9.22	12.92	13.25	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	19.94	17.01	11.83	-10.38	-12.42	9.94	20.11	17.42	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	21.35	17.83	10.65	-10.35	-10.67	10.04	22.01	18.21	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	23.65	18.85	10.30	-10.47	-9.62	9.57	23.98	18.82	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	25.64	19.20	9.20	-10.22	-8.99	9.35	25.86	19.38	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	27.38	19.11	7.85	-10.46	-8.32	9.34	27.99	19.63	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.38	18.45	6.26	-9.67	-6.62	9.26	31.03	19.48	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	32.62	18.51	5.42	-9.77	-6.55	8.33	32.58	19.16	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	33.67	18.75	4.85	-9.46	-6.01	8.49	33.87	18.98	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	34.42	18.21	4.31	-8.62	-5.08	8.77	35.07	18.04	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	37.05	17.23	3.13	-7.50	-4.62	8.69	37.67	17.14	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	38.13	17.16	3.48	-6.95	-3.97	9.02	38.61	17.20	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	38.59	16.53	3.09	-6.69	-3.35	9.61	39.69	16.89	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	40.12	16.33	3.12	-6.46	-2.70	8.83	40.14	16.23	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	40.40	15.27	2.95	-6.29	-2.62	8.92	40.86	15.79	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	43.13	14.13	1.67	-5.17	-2.83	10.20	43.09	14.29	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	43.05	13.34	2.39	-4.83	-2.31	10.68	42.39	13.83	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	43.25	13.13	2.80	-4.37	-1.40	11.14	42.39	14.09	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	44.05	12.70	2.65	-5.20	-1.47	11.13	43.36	14.66	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	43.63	10.17	0.87	-3.26	3.82	15.76	47.50	12.07	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 11. 0.10 mm high preswirl $PR = 37\%$ $\omega = 15{,}200 RPM$

Test Data									Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	7.22	9.44	26.33	-9.42	-27.41	9.29	6.91	9.23	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	10.32	11.88	22.96	-11.54	-23.82	11.07	9.53	11.82	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	12.56	7.39	20.02	-11.68	-21.23	15.35	12.42	13.77	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	19.40	17.11	14.32	-13.08	-15.21	13.06	18.94	17.68	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	21.24	17.72	12.86	-12.67	-13.23	13.13	21.67	18.07	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	23.69	17.93	11.81	-13.22	-12.16	12.42	22.86	18.50	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	25.59	18.27	10.03	-13.43	-11.12	12.22	24.83	19.08	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	27.28	18.84	9.77	-12.66	-9.87	12.33	27.13	18.71	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.36	17.01	7.23	-12.49	-7.67	11.94	30.36	18.11	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.43	17.59	7.07	-11.96	-7.57	11.60	31.52	17.73	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	32.51	17.54	6.16	-11.62	-6.90	11.58	32.73	17.31	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	33.84	16.80	4.98	-11.21	-5.90	11.14	33.68	17.03	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	36.33	15.90	3.38	-9.79	-5.23	10.77	36.67	15.86	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	37.52	16.02	3.41	-9.30	-3.98	10.69	37.40	15.55	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	37.60	14.95	3.03	-8.71	-3.27	11.02	37.79	14.88	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	39.25	15.50	3.06	-8.54	-2.54	10.31	38.25	14.45	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	39.71	14.78	2.60	-8.70	-2.30	9.86	38.42	14.41	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	36.90	14.88	3.78	-11.13	0.96	13.68	36.16	13.44	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	41.55	14.62	0.35	-9.08	-0.11	11.62	39.48	14.76	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	42.52	12.18	0.93	-5.88	-1.00	12.43	41.37	13.26	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	42.31	11.68	1.79	-6.83	-0.78	12.66	41.79	13.06	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	42.49	9.26	-0.12	-4.70	3.69	15.43	45.62	9.64	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 12. 0.10 mm high preswirl $PR = 37\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	8.23	10.26	31.91	-12.55	-34.22	13.73	8.24	9.92	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	11.50	12.88	28.14	-15.12	-29.66	15.43	10.78	12.14	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	13.71	13.13	24.45	-15.69	-26.18	16.12	13.55	14.70	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	21.30	16.89	16.31	-15.98	-18.64	16.96	20.93	18.47	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	23.23	17.57	14.88	-15.75	-16.31	17.04	23.55	18.58	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	25.45	17.95	13.70	-16.18	-14.06	16.46	25.42	18.21	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	27.63	17.48	11.37	-16.35	-12.91	16.12	27.04	18.35	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	28.92	18.25	11.29	-15.58	-11.37	15.93	29.08	18.33	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	31.64	16.66	8.17	-14.89	-8.92	15.24	31.30	17.54	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	32.93	17.08	8.16	-14.15	-8.55	14.60	33.28	17.71	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	33.95	16.78	7.15	-13.83	-7.93	14.17	34.22	17.23	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	35.21	16.08	5.71	-13.74	-6.36	13.33	34.55	16.31	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	37.26	14.86	4.02	-11.94	-5.43	13.27	37.45	15.25	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	38.33	15.01	4.02	-11.29	-4.33	12.91	38.38	14.81	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	38.55	14.42	3.69	-10.66	-3.81	13.02	38.63	14.57	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	39.70	14.43	3.67	-10.40	-2.97	12.38	39.43	14.41	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	40.11	13.67	2.96	-10.30	-3.19	12.05	39.58	14.11	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	42.32	12.41	1.93	-8.67	-3.60	13.70	41.05	12.93	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	42.70	11.92	2.00	-8.44	-1.45	13.85	41.42	13.36	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	43.24	11.30	2.02	-7.43	-1.17	13.94	42.59	12.57	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	43.48	10.54	2.18	-8.28	-0.83	13.91	42.98	12.63	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	36.61	7.52	-1.40	-9.78	3.13	20.59	43.40	10.91	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 13. 0.10 mm high preswirl $PR = 47\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	8.96	6.94	19.39	-4.92	-18.26	5.84	9.75	6.99	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	11.23	9.38	17.26	-6.81	-17.03	6.68	11.44	9.96	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	13.37	11.97	15.91	-7.49	-15.60	7.48	14.04	12.56	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	19.32	16.62	11.42	-8.52	-12.37	8.69	20.20	17.24	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	21.70	17.59	11.13	-9.49	-10.63	8.62	21.74	17.74	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	23.36	18.35	10.06	-9.12	-9.66	8.93	24.20	18.30	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	25.33	18.92	9.32	-9.38	-9.15	8.60	25.45	18.98	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	27.20	19.59	8.22	-9.72	-8.05	8.87	27.71	19.40	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.07	19.03	6.66	-8.38	-6.27	8.52	30.50	19.21	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.88	19.11	6.19	-9.14	-6.34	8.61	32.29	19.45	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	33.04	19.20	5.62	-8.83	-6.06	8.91	33.85	19.13	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	34.59	18.66	5.22	-8.30	-5.26	8.36	34.73	18.60	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	37.47	17.63	3.53	-7.82	-3.97	8.36	37.77	18.05	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	38.99	17.95	3.38	-7.45	-3.63	8.21	38.91	17.78	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	39.30	16.90	3.44	-7.34	-3.27	9.24	39.50	17.53	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	40.93	17.06	3.44	-7.10	-2.57	8.34	40.28	16.76	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	41.72	16.06	3.16	-6.99	-2.74	8.13	40.46	16.72	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	44.15	15.27	1.56	-6.17	-3.24	10.16	43.16	15.61	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	44.92	14.30	1.73	-5.95	-2.30	10.81	43.03	15.48	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	45.40	13.46	1.82	-3.77	-1.74	10.95	44.21	15.40	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	45.60	13.12	2.73	-5.02	-1.81	11.05	44.33	15.41	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	48.10	12.09	1.03	-3.60	1.97	13.66	48.66	12.17	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 14. 0.10 mm high preswirl $PR = 47\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	8.68	8.48	24.65	-8.13	-25.29	7.85	8.62	8.15	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	11.08	11.31	21.72	-10.09	-22.56	9.42	10.44	11.01	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	13.04	12.35	19.95	-10.04	-21.09	10.74	13.05	13.16	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	19.50	16.93	14.30	-12.07	-15.84	11.81	19.04	18.10	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	21.57	17.74	12.92	-11.88	-13.79	12.35	21.61	18.22	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	23.83	18.67	12.78	-12.56	-12.11	11.97	23.14	18.34	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	25.78	18.76	10.25	-13.19	-11.54	11.99	25.07	19.61	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	27.03	19.57	10.76	-12.03	-10.43	11.90	26.95	19.84	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.68	18.12	7.36	-11.99	-7.89	11.97	30.40	19.40	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	31.86	18.96	8.08	-11.56	-7.51	11.88	32.08	19.20	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	33.04	18.50	6.87	-11.49	-7.35	11.17	32.99	19.07	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	35.01	17.81	5.29	-11.54	-5.97	10.89	34.10	18.64	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	37.14	16.76	3.81	-10.37	-5.25	10.29	37.45	17.64	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	38.65	17.24	3.55	-9.84	-4.27	10.43	38.39	17.32	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	38.99	16.25	3.62	-9.18	-4.00	11.07	38.86	16.69	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	40.30	16.99	3.53	-9.03	-2.69	10.71	39.45	16.11	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	41.28	16.30	3.21	-9.34	-2.41	10.49	39.87	15.99	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	37.24	16.49	3.88	-13.53	0.99	14.85	37.33	17.22	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	43.28	15.52	-0.28	-9.34	-0.43	12.30	41.81	16.25	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	43.78	13.38	0.56	-5.54	-1.54	12.76	43.11	14.86	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	44.33	12.81	2.36	-6.25	-1.09	12.68	44.01	14.87	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	46.10	10.72	0.45	-5.81	2.77	14.75	48.36	11.76	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 15. 0.10 mm high preswirl $PR = 47\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	10.89	8.43	28.96	-10.03	-30.89	10.14	10.12	8.15	0.269	0.223	0.372	0.192	0.527	0.280	0.324	0.241
30	13.74	10.45	26.05	-12.57	-27.67	12.54	12.01	10.80	0.257	0.243	0.334	0.204	0.472	0.252	0.325	0.274
40	15.38	11.82	23.03	-13.31	-24.19	13.96	14.78	12.31	0.454	0.402	0.352	0.268	0.403	0.384	0.402	0.232
70	21.32	15.34	16.19	-13.98	-17.98	15.00	21.63	16.78	0.253	0.321	0.388	0.273	0.459	0.279	0.589	0.450
80	23.22	16.08	14.71	-14.31	-16.11	15.05	23.27	17.37	0.505	0.411	0.349	0.329	0.340	0.312	0.503	0.309
90	25.14	16.83	13.89	-14.61	-14.46	15.26	25.24	17.39	0.369	0.328	0.245	0.135	0.254	0.187	0.271	0.367
100	26.81	16.93	12.11	-14.55	-12.78	14.51	26.42	17.66	0.440	0.378	0.314	0.217	0.278	0.342	0.548	0.367
110	28.33	17.39	11.52	-14.48	-11.37	14.71	28.49	17.47	0.391	0.349	0.291	0.195	0.206	0.254	0.480	0.321
130	30.86	16.12	8.50	-13.64	-9.04	13.79	30.77	17.58	0.434	0.407	0.311	0.182	0.256	0.304	0.605	0.380
140	32.31	17.07	8.72	-13.22	-8.48	13.81	32.55	17.37	0.497	0.371	0.202	0.237	0.228	0.347	0.610	0.340
150	33.31	16.99	7.82	-13.15	-7.05	13.93	34.09	17.11	0.472	0.399	0.185	0.077	0.226	0.304	0.610	0.281
160	35.30	16.03	6.63	-13.16	-6.77	13.06	34.60	16.96	0.529	0.360	0.272	0.122	0.129	0.258	0.618	0.305
190	37.39	14.89	4.45	-12.32	-5.59	12.79	37.72	15.92	0.522	0.344	0.156	0.173	0.195	0.271	0.644	0.259
200	38.37	15.42	4.39	-11.62	-4.25	12.53	38.84	14.95	0.632	0.380	0.188	0.186	0.144	0.260	0.654	0.326
210	38.68	14.37	3.78	-11.18	-3.73	12.40	38.89	14.91	0.627	0.366	0.127	0.167	0.164	0.269	0.644	0.255
220	40.16	15.02	3.97	-10.95	-3.35	12.31	39.65	14.70	0.626	0.367	0.134	0.150	0.171	0.255	0.645	0.259
230	40.77	13.79	3.05	-11.06	-3.25	12.14	40.61	14.33	0.674	0.322	0.131	0.182	0.157	0.209	0.678	0.224
260	43.82	12.32	1.11	-9.60	-3.84	13.65	42.27	12.92	0.769	0.548	0.571	0.590	0.456	0.531	1.048	0.791
270	43.79	11.86	1.25	-8.71	-1.72	13.49	41.91	13.31	0.619	0.412	0.409	0.437	0.257	0.289	0.725	0.550
280	43.78	10.63	1.53	-6.85	-1.46	13.85	42.76	12.92	0.628	0.409	0.307	0.287	0.170	0.293	0.622	0.188
290	43.83	10.77	2.28	-8.09	-1.69	14.62	43.04	13.01	0.693	0.335	0.195	0.295	0.128	0.220	0.635	0.293
330	36.93	9.59	-2.59	-8.61	3.72	21.37	46.48	11.52	0.712	0.342	0.333	0.257	0.296	0.460	0.645	0.352

Table 16. 0.10 mm medium preswirl $PR = 17\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.64	10.79	22.81	-10.12	-22.19	9.73	1.73	14.27	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	6.15	13.93	18.87	-11.26	-18.53	10.90	6.03	17.02	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	9.70	15.64	16.03	-12.10	-16.05	11.61	9.71	18.83	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	17.46	18.89	10.82	-11.12	-10.00	11.08	18.75	20.80	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	20.00	19.50	9.78	-11.50	-8.72	11.02	21.16	21.53	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	22.21	19.47	8.47	-11.43	-8.03	10.27	23.39	22.11	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	23.46	19.35	7.13	-10.57	-7.28	9.98	25.69	21.28	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	25.46	19.39	6.79	-10.34	-6.50	10.15	27.66	21.50	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	28.47	18.82	5.58	-9.40	-4.98	9.67	30.75	20.60	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	29.58	18.59	4.96	-9.39	-4.35	8.77	32.06	20.34	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	30.77	18.23	4.42	-9.03	-3.90	8.41	33.18	19.68	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	31.65	17.51	3.80	-8.30	-2.92	8.31	34.22	18.97	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	33.68	15.75	3.14	-7.72	-1.70	7.64	36.79	17.49	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	35.42	16.56	2.92	-7.25	-1.38	7.25	37.47	16.96	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	35.70	16.01	2.92	-6.86	-0.59	7.64	38.24	16.70	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	37.14	15.60	2.77	-6.65	0.06	6.53	38.65	16.13	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	37.50	14.80	2.68	-6.61	0.32	6.01	38.84	15.68	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	39.53	14.12	1.67	-5.84	-0.29	4.71	40.20	15.28	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	40.61	13.32	2.31	-5.79	-0.49	6.09	41.65	15.59	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	41.14	11.54	1.26	-4.67	0.51	7.09	43.57	12.36	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	40.84	10.63	2.08	-5.11	1.89	6.01	41.76	12.42	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	39.72	8.74	1.11	-2.71	2.48	6.08	42.50	9.89	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 17. 0.10 mm medium preswirl $PR = 17\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	1.85	12.71	30.85	-14.31	-29.06	13.28	1.32	15.11	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	6.45	16.12	25.86	-16.45	-24.31	14.75	6.05	18.26	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	9.57	15.68	20.70	-16.37	-20.83	16.02	10.50	20.56	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	18.41	18.91	12.79	-14.89	-13.93	14.83	19.67	22.54	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	20.97	19.46	11.83	-15.17	-11.81	14.45	22.39	21.80	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	23.24	19.66	10.62	-15.31	-10.47	13.84	24.72	22.10	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	24.82	19.94	9.28	-14.37	-9.32	12.98	26.15	21.40	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	26.22	19.64	8.65	-13.45	-8.09	12.94	28.38	21.13	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	29.48	18.10	6.14	-12.69	-6.31	12.03	31.12	20.16	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	30.52	18.34	6.19	-12.03	-5.44	12.02	33.04	19.65	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	32.04	17.90	5.47	-11.71	-5.48	11.34	33.95	19.38	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	32.84	17.21	4.44	-11.07	-3.86	11.28	34.82	18.34	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	34.45	15.60	3.43	-9.94	-1.58	10.01	37.25	16.92	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	36.34	15.93	3.14	-9.49	-1.37	9.61	37.91	16.51	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	36.38	15.47	3.19	-9.02	-0.38	9.58	38.65	16.09	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	37.56	14.88	3.22	-8.81	0.09	8.64	38.97	15.74	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	37.69	14.68	3.18	-8.67	0.66	8.21	39.25	15.01	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	31.34	13.02	5.23	-9.17	2.32	14.73	37.79	12.70	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	38.62	14.26	2.46	-10.08	2.32	9.22	40.18	15.37	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	40.57	11.72	0.52	-7.19	1.11	8.48	43.37	13.16	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	40.63	10.85	1.75	-7.44	1.98	7.87	41.96	12.55	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	40.98	8.52	1.60	-4.15	2.38	7.14	42.65	9.19	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 18. 0.10 mm medium preswirl $PR = 17\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.38	12.36	36.47	-17.27	-36.75	17.41	6.08	13.80	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	8.74	16.00	30.38	-19.69	-30.03	19.31	10.42	16.60	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	12.66	17.28	25.11	-20.26	-25.20	20.05	14.43	17.85	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	21.09	17.82	15.48	-18.09	-16.39	18.31	23.10	19.82	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	22.77	17.96	13.87	-17.37	-14.07	17.80	24.91	19.45	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	24.65	18.09	12.53	-16.77	-12.17	17.17	26.79	19.04	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	26.56	17.45	10.87	-16.25	-11.24	16.55	28.58	19.16	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	28.01	17.66	10.08	-15.84	-9.50	16.10	30.54	18.71	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	30.75	16.65	7.87	-14.75	-7.53	15.08	32.69	17.58	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	31.55	16.68	7.64	-13.92	-6.37	14.33	34.17	17.27	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	33.23	16.16	6.74	-13.81	-5.63	13.82	34.82	16.76	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	33.83	15.89	6.18	-12.92	-4.80	13.52	35.83	15.92	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	35.41	13.70	4.81	-12.03	-2.28	12.07	38.10	14.81	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	36.91	13.79	4.31	-11.58	-2.00	11.58	38.71	14.43	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	36.84	13.27	4.13	-11.15	-1.11	10.65	38.85	13.89	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	37.86	12.84	4.13	-10.98	-0.73	10.13	39.53	13.67	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	38.42	12.59	3.62	-10.68	-0.38	9.65	39.67	13.38	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	39.75	11.62	2.65	-10.22	-0.71	8.01	41.20	13.59	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	40.15	11.19	2.49	-10.03	-0.66	8.78	42.75	14.00	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	41.14	10.22	1.50	-9.26	0.94	9.45	43.82	10.78	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	41.29	9.31	2.12	-9.16	1.51	8.76	42.17	10.22	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	35.05	3.10	2.35	-12.57	0.98	15.63	37.32	10.73	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 19. 0.10 mm medium preswirl $PR = 27\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.80	10.48	22.00	-9.37	-21.18	8.14	3.38	12.82	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	8.26	13.16	18.66	-11.17	-17.90	9.73	7.33	15.48	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	10.55	14.65	15.86	-11.10	-15.79	10.41	11.17	17.62	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	18.29	17.70	10.64	-11.28	-10.55	10.35	19.11	20.22	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	20.44	18.35	9.39	-11.11	-9.50	10.61	21.72	20.86	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	22.28	18.74	8.69	-10.84	-7.96	10.12	23.70	20.75	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	24.36	18.72	7.39	-10.82	-7.17	9.72	25.83	20.40	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	25.58	18.50	6.78	-10.30	-6.36	9.36	27.71	20.71	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	29.02	17.53	5.08	-9.60	-4.71	8.79	30.58	19.19	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	29.97	17.82	5.13	-9.31	-4.10	8.78	31.94	19.20	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	31.38	17.42	4.58	-8.94	-4.00	8.36	33.14	18.80	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	32.24	17.37	4.00	-8.66	-3.09	8.17	34.07	18.12	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	33.60	15.36	3.00	-7.62	-1.53	7.67	36.84	16.71	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	35.62	15.95	2.92	-7.33	-1.40	7.11	37.47	16.18	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	35.85	15.44	2.82	-6.68	-0.68	7.27	38.13	15.64	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	37.31	15.24	3.04	-6.66	-0.04	6.72	38.56	15.39	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	37.91	14.08	2.51	-6.42	0.06	6.24	39.00	14.93	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	39.77	13.43	1.77	-6.00	-0.53	5.32	40.44	14.52	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	41.02	12.10	2.00	-5.65	-0.10	6.42	41.74	14.01	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	41.04	10.80	1.88	-4.98	0.96	6.60	42.63	12.46	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	41.28	10.61	2.07	-5.33	1.69	5.62	41.79	11.89	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	41.63	9.70	0.90	-3.04	0.88	5.44	42.02	10.12	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 20. 0.10 mm medium preswirl $PR = 27\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.07	12.46	28.75	-14.62	-26.07	12.40	3.46	12.09	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	9.74	14.55	23.58	-16.95	-22.65	13.38	6.94	15.25	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	9.99	13.26	18.51	-14.94	-19.55	14.84	11.24	18.42	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	18.45	17.34	11.21	-13.54	-13.96	13.53	19.38	21.17	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	20.22	18.08	10.58	-12.76	-11.66	13.66	22.57	20.66	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	23.09	18.86	10.94	-13.90	-10.24	13.40	25.26	19.96	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	24.40	18.40	7.89	-13.84	-9.42	12.33	25.57	19.98	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	26.28	19.32	9.32	-13.08	-7.70	13.13	29.40	19.46	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	29.28	17.18	5.32	-12.52	-6.24	11.92	30.93	18.44	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	30.19	17.59	6.83	-11.15	-5.20	11.72	33.10	18.26	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	31.70	17.55	6.11	-11.20	-5.05	11.57	34.07	17.95	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	32.54	16.40	4.01	-11.27	-4.05	10.52	33.93	17.06	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	33.95	15.19	3.06	-9.92	-1.68	9.85	36.94	15.97	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	36.30	15.64	3.01	-9.58	-1.62	9.14	37.27	15.40	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	36.64	14.98	3.02	-8.58	-0.79	9.46	38.13	15.16	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	37.92	14.92	3.19	-8.45	0.13	8.47	38.42	14.83	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	37.89	14.18	2.60	-8.42	0.38	7.61	38.51	14.38	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	34.17	17.41	3.68	-11.78	4.97	10.48	35.61	14.35	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	41.32	14.65	0.28	-9.26	2.27	6.93	40.07	16.02	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	41.17	11.09	1.03	-6.16	1.06	8.17	43.28	12.92	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	40.73	10.74	1.69	-6.70	2.28	7.34	41.98	12.00	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	42.03	8.24	1.92	-4.40	1.87	6.41	42.99	8.22	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 21. 0.10 mm medium preswirl $PR = 27\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	10.34	11.94	38.22	-18.57	-34.09	15.31	5.54	11.47	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	13.78	13.88	30.73	-21.73	-28.46	18.29	11.09	14.93	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	15.41	13.46	24.03	-21.08	-24.02	18.51	15.11	16.42	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	21.73	14.92	14.67	-17.97	-15.39	16.48	22.52	17.54	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	23.32	15.38	13.17	-17.42	-13.41	16.40	24.74	17.71	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	25.22	15.91	12.51	-16.98	-11.61	16.02	27.04	17.53	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	26.53	15.84	10.82	-16.47	-10.23	15.24	27.91	17.13	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	28.00	15.97	9.95	-15.83	-8.87	14.75	30.33	17.05	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	30.63	14.85	7.71	-14.89	-7.52	13.70	32.11	16.44	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	31.75	14.86	7.84	-14.07	-6.36	13.37	33.69	16.21	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	32.70	14.94	7.18	-13.92	-5.41	12.91	34.65	15.57	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	33.49	14.02	5.90	-13.50	-4.70	12.70	35.14	14.96	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	34.80	12.47	4.47	-12.46	-2.03	11.31	37.60	13.72	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	36.17	12.72	4.40	-11.75	-2.26	10.38	37.84	13.36	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	36.32	12.37	4.17	-11.30	-1.52	10.57	38.55	13.03	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	37.46	11.96	4.00	-11.16	-1.06	9.99	38.94	12.98	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	37.73	11.46	3.53	-11.04	-0.70	9.30	39.02	12.53	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	39.71	10.67	2.47	-10.85	-0.55	8.03	40.25	13.10	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	40.41	10.06	1.63	-10.29	-0.24	8.33	42.00	13.82	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	40.73	9.15	1.56	-8.66	0.47	9.26	43.78	10.37	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	40.88	8.41	1.70	-9.38	1.69	8.70	42.42	9.86	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	35.80	5.02	-0.74	-13.50	1.07	13.58	39.04	12.87	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 22. 0.10 mm medium preswirl $PR = 37\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.68	9.24	20.49	-7.94	-19.05	6.78	4.45	11.66	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	9.31	11.93	17.92	-9.54	-16.42	8.21	8.01	14.59	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	12.01	13.37	15.49	-9.80	-13.99	9.10	11.42	15.96	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	19.03	17.61	10.74	-10.61	-9.67	9.15	19.82	20.45	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	20.62	17.92	9.72	-9.91	-8.99	8.64	21.77	20.77	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	23.04	18.41	9.20	-10.48	-7.72	9.24	23.82	20.95	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	24.63	19.09	7.63	-9.92	-6.53	8.68	26.13	21.09	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	26.27	18.79	7.74	-10.02	-6.12	8.59	27.67	21.18	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	29.42	17.86	5.48	-9.38	-4.70	8.61	31.89	20.57	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	30.68	18.42	5.72	-9.01	-4.04	8.13	32.68	19.69	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	31.76	17.79	5.25	-8.56	-3.54	7.87	33.67	19.12	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	33.35	17.27	3.58	-8.56	-3.40	7.88	35.06	19.61	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	34.98	16.31	3.88	-7.52	-1.11	7.18	38.07	17.96	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	37.44	17.02	3.53	-7.41	-1.13	6.77	38.99	17.56	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	37.74	15.88	3.28	-6.67	-0.32	7.20	39.60	16.94	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	38.99	15.42	3.40	-6.46	0.12	6.69	39.90	16.57	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	39.23	14.80	3.01	-6.54	0.78	5.96	40.55	16.13	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	41.90	14.03	2.23	-6.26	0.55	5.23	42.42	15.54	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	43.03	13.20	2.13	-5.95	0.65	5.70	43.41	14.98	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	42.91	11.40	1.86	-4.19	1.72	6.58	44.46	13.00	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	42.68	10.94	2.70	-5.32	2.40	5.57	43.20	12.61	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	42.52	9.16	1.28	-2.28	3.49	6.14	44.53	11.32	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 23. 0.10 mm medium preswirl $PR = 37\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.77	9.12	28.55	-8.64	-26.66	10.19	5.12	12.54	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	7.14	13.15	24.70	-11.40	-22.82	11.90	8.66	15.35	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	9.91	8.56	20.90	-11.19	-20.46	15.61	12.19	17.50	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	18.78	18.26	13.80	-12.25	-14.36	12.97	20.80	21.70	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	21.31	19.01	12.58	-13.05	-11.98	13.83	23.83	20.86	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	23.55	19.18	10.79	-12.90	-10.78	12.82	25.43	21.11	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	25.15	19.52	10.04	-12.29	-9.87	12.25	27.16	21.24	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	27.11	19.89	9.31	-12.25	-8.47	12.68	29.40	21.08	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	30.42	18.18	7.11	-11.41	-6.60	12.25	32.93	19.88	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	31.72	18.25	6.66	-11.16	-5.48	11.60	34.25	19.30	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	33.16	18.75	6.25	-11.00	-5.40	11.06	34.94	19.11	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	34.13	17.56	4.88	-10.51	-4.08	10.65	36.04	18.44	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	36.20	16.23	4.06	-9.70	-1.70	10.46	39.18	17.27	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	38.37	17.20	4.01	-9.47	-1.60	9.69	39.72	16.91	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	38.75	15.83	3.83	-8.99	-0.32	9.76	40.10	16.38	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	39.85	15.54	3.75	-8.81	0.31	8.74	40.74	15.83	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	39.67	15.28	3.61	-8.87	0.93	8.51	40.79	15.50	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	35.26	14.11	6.75	-10.27	3.99	14.33	39.12	12.65	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	41.67	15.47	2.69	-11.40	3.89	9.12	41.10	15.46	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	43.72	11.91	0.87	-7.48	2.08	9.01	44.57	14.08	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	42.88	11.58	2.43	-8.04	3.05	8.27	43.93	13.41	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	44.00	9.41	1.45	-4.75	3.07	7.29	45.88	10.32	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 24. 0.10 mm medium preswirl $PR = 37\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	11.37	10.88	35.80	-15.52	-32.34	13.78	9.39	10.29	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	14.24	12.11	29.77	-18.52	-28.26	15.79	12.66	13.58	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	15.43	11.68	24.88	-17.85	-24.24	16.35	16.77	15.58	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	21.92	15.09	15.79	-16.61	-16.88	15.78	23.56	18.83	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	23.46	15.83	14.48	-15.83	-14.42	16.07	26.15	18.30	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	25.69	16.75	13.81	-16.74	-12.52	15.70	28.10	17.73	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	27.35	15.98	11.17	-16.29	-11.52	15.13	29.08	17.99	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	28.87	17.14	11.74	-15.93	-9.55	15.44	31.73	17.72	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	31.60	15.81	8.33	-14.98	-8.24	14.15	33.70	17.12	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	32.55	16.13	8.88	-13.99	-6.77	13.96	35.73	17.00	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	33.89	16.06	8.01	-13.68	-6.03	13.42	36.50	16.34	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	35.04	15.20	6.30	-13.49	-4.71	12.70	37.06	15.78	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	36.65	13.81	5.24	-12.26	-2.27	12.27	39.83	14.53	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	38.29	13.86	4.97	-12.14	-2.20	11.13	40.33	14.21	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	38.38	13.25	4.70	-11.18	-1.78	11.15	40.60	14.03	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	39.27	12.75	4.75	-10.86	-0.80	10.46	41.57	13.90	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	39.68	12.33	4.10	-10.94	-0.48	10.05	41.45	13.39	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	41.49	11.84	3.44	-10.01	-0.04	8.74	43.17	13.58	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	42.50	10.97	3.19	-9.68	-0.28	8.84	44.78	14.26	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	42.96	9.97	3.03	-8.93	0.77	9.83	45.82	10.40	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	43.10	9.54	2.99	-9.65	2.29	9.11	44.71	11.10	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	38.38	5.74	1.78	-13.26	2.16	13.72	40.47	11.69	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 25. 0.10 mm medium preswirl $PR = 47\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	7.49	8.55	19.97	-7.16	-17.93	5.56	6.43	9.99	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	9.98	11.27	17.82	-8.81	-16.05	6.99	8.96	13.36	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	12.18	12.84	15.81	-8.74	-14.09	7.52	12.15	15.23	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	18.84	17.43	10.57	-9.72	-10.20	8.66	20.10	20.13	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	20.74	18.60	10.29	-9.76	-9.42	8.79	22.15	20.85	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	22.90	19.00	9.71	-10.21	-8.27	8.84	24.38	21.55	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	24.73	19.34	8.24	-9.93	-7.61	8.94	26.85	21.87	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	26.47	19.81	8.05	-9.95	-6.38	8.69	28.31	21.59	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	29.80	18.95	6.23	-9.07	-5.09	8.51	31.78	21.49	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	31.09	19.16	6.42	-8.88	-4.45	8.24	32.98	21.17	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	32.17	18.97	5.93	-8.55	-4.01	7.74	34.20	20.84	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	33.65	18.37	4.34	-8.53	-3.78	8.02	36.20	21.05	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	36.00	17.06	4.17	-7.88	-0.87	7.60	39.47	19.57	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	38.23	17.98	3.78	-7.46	-1.36	6.56	40.31	18.89	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	38.96	16.93	3.90	-7.33	-0.44	7.29	40.74	18.50	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	39.75	16.46	3.94	-6.94	-0.15	6.62	41.65	17.97	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	40.41	15.98	3.72	-6.89	0.60	5.81	42.07	17.50	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	42.70	15.43	2.94	-6.73	0.58	4.98	44.30	17.28	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	44.29	14.42	2.60	-6.66	0.22	5.80	45.50	17.23	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	44.43	13.45	2.15	-5.57	0.74	6.50	47.25	14.52	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	44.03	12.77	2.90	-6.26	1.81	5.94	44.70	14.18	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	44.72	9.50	0.56	-4.89	2.34	7.21	48.20	14.14	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 26. 0.10 mm medium preswirl $PR = 47\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.70	8.98	25.75	-9.41	-25.27	8.86	6.52	10.56	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	8.83	11.88	22.75	-10.94	-22.25	10.81	9.51	13.80	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	11.88	13.56	20.27	-11.62	-20.11	11.94	12.83	15.96	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	19.35	17.97	13.71	-13.24	-14.13	12.19	19.94	20.37	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	21.30	18.60	12.67	-12.85	-12.69	12.59	22.99	20.47	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	23.22	19.32	12.17	-13.32	-11.26	12.41	25.11	20.94	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	25.34	19.61	10.37	-13.43	-10.22	12.45	27.08	21.19	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	27.01	19.98	9.92	-12.85	-8.53	12.50	29.28	20.99	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	30.05	18.94	7.13	-11.78	-6.54	11.94	32.41	20.00	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	31.73	18.99	7.57	-11.23	-5.82	11.70	34.00	20.25	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	32.99	19.05	6.76	-11.32	-5.67	11.35	35.32	20.02	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	34.41	18.28	5.63	-11.31	-4.16	11.00	36.20	19.26	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	36.29	16.64	4.45	-10.28	-1.65	10.46	39.37	18.21	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	38.34	17.74	4.19	-9.87	-1.49	9.90	40.17	17.74	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	39.20	16.58	4.24	-9.48	-0.45	9.84	40.54	17.06	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	40.27	16.45	4.45	-9.15	0.29	9.26	41.50	16.74	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	40.28	15.57	3.97	-9.17	0.70	8.90	41.87	16.24	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	34.43	14.69	7.23	-13.30	3.68	16.35	39.27	15.61	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	41.78	15.56	2.62	-11.77	3.56	10.46	43.10	16.18	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	43.60	12.52	1.09	-7.49	1.80	10.06	45.67	14.46	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	43.31	12.09	2.42	-8.02	2.98	9.20	44.78	13.97	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	45.46	9.95	1.69	-6.05	2.28	8.11	47.61	12.21	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 27. 0.10 mm medium preswirl $PR = 47\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	12.19	8.59	32.78	-12.28	-31.03	11.68	12.15	8.99	0.230	0.163	0.181	0.149	0.244	0.168	0.404	0.143
30	14.66	10.57	28.39	-14.88	-27.15	13.89	14.70	11.75	0.305	0.165	0.184	0.209	0.141	0.200	0.328	0.102
40	17.17	11.53	24.20	-16.26	-23.59	15.26	18.20	13.32	0.454	0.348	0.142	0.230	0.300	0.307	0.325	0.259
70	22.94	14.82	16.72	-16.14	-16.84	15.13	25.05	17.29	0.309	0.147	0.192	0.191	0.133	0.083	0.453	0.239
80	24.25	15.39	14.88	-15.59	-14.65	15.59	27.10	17.15	0.471	0.110	0.194	0.266	0.166	0.148	0.397	0.245
90	26.16	16.18	13.66	-15.59	-12.94	15.27	28.86	16.87	0.288	0.248	0.268	0.111	0.139	0.134	0.238	0.266
100	27.71	16.34	12.40	-14.95	-11.90	14.91	30.31	17.61	0.245	0.121	0.146	0.147	0.118	0.114	0.182	0.187
110	28.98	16.45	11.27	-14.64	-10.07	15.10	32.26	17.32	0.246	0.096	0.204	0.177	0.129	0.170	0.299	0.172
130	31.96	15.81	9.21	-13.95	-8.40	14.71	35.00	16.74	0.405	0.216	0.192	0.202	0.080	0.123	0.324	0.166
140	33.34	15.61	8.65	-13.76	-6.97	13.60	35.85	16.84	0.265	0.200	0.178	0.121	0.237	0.188	0.330	0.211
150	34.35	15.74	8.12	-13.54	-6.05	13.44	37.34	16.51	0.356	0.182	0.115	0.130	0.236	0.167	0.286	0.302
160	35.68	15.15	7.56	-13.13	-5.07	12.92	38.15	15.89	0.270	0.129	0.170	0.090	0.063	0.105	0.304	0.159
190	37.06	13.51	5.59	-12.63	-2.19	11.94	40.86	14.78	0.298	0.168	0.132	0.135	0.098	0.165	0.257	0.165
200	39.15	14.37	5.47	-12.08	-2.29	11.08	41.68	14.06	0.372	0.221	0.109	0.187	0.111	0.190	0.224	0.173
210	39.44	13.58	5.02	-11.93	-1.77	10.51	42.18	13.89	0.236	0.190	0.074	0.137	0.155	0.277	0.245	0.090
220	40.58	12.80	4.73	-11.69	-0.99	10.25	42.75	13.62	0.191	0.277	0.181	0.112	0.141	0.204	0.259	0.202
230	40.67	12.33	4.28	-11.43	-0.81	9.62	43.18	13.00	0.229	0.102	0.088	0.195	0.151	0.189	0.176	0.207
260	43.56	11.45	2.65	-11.05	-0.19	8.87	44.97	12.75	0.612	0.372	0.576	0.595	0.639	0.652	0.811	0.758
270	43.75	10.79	2.44	-10.35	-0.54	9.33	45.72	13.11	0.356	0.304	0.328	0.375	0.468	0.533	0.394	0.325
280	43.90	9.65	2.81	-8.69	0.92	9.91	46.71	9.93	0.218	0.211	0.326	0.431	0.188	0.288	0.303	0.240
290	44.08	9.42	2.76	-9.44	2.24	9.01	45.37	10.59	0.329	0.173	0.205	0.165	0.182	0.236	0.376	0.188
330	39.46	6.64	0.98	-13.16	2.61	12.11	43.12	11.50	0.404	0.320	0.321	0.283	0.350	0.736	0.379	0.568

Table 28. 0.10 mm zero preswirl $PR = 17\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.13	12.70	20.59	-8.99	-21.11	8.86	2.24	13.52	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	6.21	16.03	17.51	-10.69	-17.66	9.94	6.23	16.45	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	9.80	17.42	14.72	-11.70	-15.10	10.90	9.98	18.12	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	18.87	20.58	9.78	-11.70	-10.13	10.60	18.68	21.33	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	20.46	20.81	8.21	-11.27	-8.00	10.35	20.88	21.17	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	23.04	21.64	6.98	-11.02	-7.00	9.41	22.85	21.78	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	25.42	22.19	6.22	-10.89	-6.55	8.84	25.16	21.98	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	27.26	21.73	5.25	-10.50	-5.98	8.71	27.01	22.25	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	29.98	20.57	3.70	-9.69	-4.89	8.61	30.86	21.15	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	32.44	20.18	2.90	-9.96	-4.68	7.98	32.27	20.65	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	33.87	20.18	2.43	-9.53	-4.36	7.62	33.33	20.22	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	34.56	19.36	2.20	-8.93	-4.07	7.42	34.25	19.44	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	36.55	18.04	1.07	-7.24	-3.46	7.37	37.24	18.28	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	37.89	18.06	0.93	-6.95	-2.66	7.50	37.82	17.96	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	38.08	17.43	0.95	-6.54	-2.01	7.71	38.74	17.92	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	39.40	17.49	0.80	-6.20	-1.95	7.08	39.26	17.34	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	39.95	16.79	0.73	-5.86	-1.98	7.01	40.09	17.17	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	42.27	15.09	-0.21	-4.72	-2.12	8.24	42.39	14.13	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	42.72	14.04	0.77	-3.62	-1.09	8.79	41.20	13.02	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	43.56	13.54	1.42	-3.72	-0.55	8.76	41.12	14.47	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	43.74	12.82	1.46	-4.65	-0.50	8.66	42.43	14.83	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	40.46	11.42	-0.85	-2.32	3.84	10.85	44.98	11.88	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 29. 0.10 mm zero preswirl $PR = 17\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	1.47	14.83	30.15	-13.01	-28.43	14.41	4.22	14.05	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	8.96	17.80	25.12	-17.79	-23.11	14.66	6.83	16.42	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	11.17	15.87	18.57	-17.64	-18.25	14.95	10.16	17.63	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	20.20	18.66	11.68	-16.57	-13.16	13.97	18.63	21.21	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	20.26	19.58	10.12	-14.45	-10.36	13.82	21.57	20.81	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	23.71	21.05	9.46	-15.06	-9.41	12.32	23.40	20.95	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	26.67	21.04	8.31	-15.13	-9.19	11.85	25.19	21.80	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	27.34	20.41	7.09	-13.67	-7.66	11.96	27.54	21.45	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	30.10	19.12	5.17	-12.71	-6.67	11.85	31.25	20.30	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	32.42	18.56	4.11	-12.33	-5.93	10.87	32.32	19.98	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	33.78	19.03	3.93	-12.22	-5.33	10.82	33.56	19.16	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	34.92	18.34	2.74	-11.86	-4.61	9.54	34.05	18.74	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	36.74	17.22	1.57	-9.77	-4.06	9.53	37.22	17.47	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	37.73	16.96	1.47	-8.83	-3.70	9.59	38.14	17.32	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	37.65	16.60	1.11	-8.37	-2.63	9.94	38.95	17.09	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	39.32	17.10	1.04	-7.96	-1.88	8.80	39.48	16.71	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	40.16	16.39	0.37	-7.83	-2.07	7.94	39.92	17.23	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	38.84	19.48	-6.98	-12.88	3.92	12.17	35.97	21.96	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	44.00	15.02	-6.28	-2.23	-0.34	8.55	45.45	18.76	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	42.95	12.95	1.49	-2.87	-0.65	10.48	43.37	13.41	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	43.39	12.34	1.56	-5.90	-0.37	10.32	42.93	14.28	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	41.07	10.40	-0.54	-3.89	3.17	12.17	45.20	10.85	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 30. 0.10 mm zero preswirl $PR = 17\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
v	8.88	13.39	42.84	-21.49	-36.17	18.37	6.25	13.66	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	14.20	15.57	34.48	-25.24	-29.99	20.46	11.50	16.59	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	17.92	14.96	25.67	-25.85	-24.12	20.27	15.02	16.63	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	23.25	15.98	15.50	-21.07	-15.81	18.37	22.98	19.12	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	23.81	17.01	13.88	-19.47	-12.80	17.53	24.50	18.74	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	26.82	18.04	12.86	-19.49	-11.10	16.43	26.57	18.97	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	28.14	18.31	11.33	-18.48	-10.51	16.23	28.98	19.25	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	30.23	17.49	9.46	-18.01	-9.98	15.00	30.62	19.93	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	32.41	16.41	7.44	-16.86	-7.99	14.43	33.01	18.00	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	34.56	15.98	5.85	-16.47	-7.26	13.33	33.85	17.96	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	35.18	16.71	5.71	-15.68	-6.44	13.56	35.28	17.23	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	36.54	15.68	4.90	-15.25	-5.31	12.68	36.29	16.80	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	38.14	15.03	3.08	-12.88	-5.08	11.81	38.43	15.81	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	39.00	14.72	2.70	-12.05	-4.27	11.64	39.12	15.59	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	39.05	14.23	2.56	-11.61	-3.35	11.61	39.74	15.26	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	40.44	14.43	2.50	-11.30	-3.16	11.00	40.11	15.24	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	40.88	13.81	2.39	-10.89	-3.18	10.82	41.02	14.97	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	43.18	12.50	1.21	-9.66	-2.78	11.80	43.37	13.36	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	43.07	11.50	1.48	-8.16	-1.46	12.18	42.73	12.87	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	43.90	11.06	2.17	-7.72	-1.02	11.81	43.84	12.94	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	44.33	10.29	1.76	-9.15	-1.36	11.97	43.76	13.02	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	36.77	8.61	-2.53	-14.30	2.26	18.57	37.49	14.69	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 31. 0.10 mm zero preswirl $PR = 27\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.27	11.01	19.52	-7.17	-19.68	7.50	5.83	11.17	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	9.77	14.61	17.31	-8.93	-17.45	8.67	8.92	14.37	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	13.64	16.46	14.42	-10.83	-15.22	9.74	12.30	16.68	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	22.23	19.94	9.99	-11.57	-10.98	10.27	20.67	20.26	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	24.00	19.99	8.09	-11.38	-9.01	9.88	22.85	20.72	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	26.15	20.56	6.45	-10.58	-8.06	9.14	24.87	21.20	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	27.97	21.44	7.08	-9.95	-7.55	9.00	27.18	20.89	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	30.00	20.99	4.90	-10.43	-6.33	9.19	29.10	21.82	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	33.16	20.18	4.36	-9.33	-5.57	8.54	32.81	20.66	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	35.41	19.91	2.57	-10.39	-5.35	7.65	34.20	20.54	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	36.97	19.90	2.31	-9.97	-4.62	7.27	35.26	19.82	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	36.77	19.72	2.25	-8.01	-4.27	6.88	37.06	19.09	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	40.49	17.92	1.25	-7.75	-4.56	7.83	39.18	18.14	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	41.63	17.73	0.68	-6.51	-3.97	7.83	40.34	17.65	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	41.59	17.48	0.64	-6.73	-2.53	7.92	40.99	17.78	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	43.30	17.18	0.50	-6.54	-2.25	7.12	42.02	17.15	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	42.98	16.36	0.50	-6.26	-2.52	7.00	42.38	16.93	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	46.58	14.80	-1.84	-4.54	-2.44	8.15	45.97	13.66	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	46.98	12.71	-0.77	-1.73	-1.90	9.05	44.46	11.47	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	45.97	13.30	2.13	-2.67	-0.69	9.01	43.08	13.08	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	47.05	13.16	1.45	-4.22	-0.62	8.16	44.58	14.30	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	46.47	11.28	0.28	-1.86	0.46	11.10	46.10	11.06	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 32. 0.10 mm zero preswirl $PR = 27\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.06	12.98	28.64	-12.16	-29.07	12.38	5.05	13.51	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	8.27	17.01	25.42	-14.26	-24.85	13.16	7.68	16.18	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	11.60	17.10	20.91	-15.97	-20.04	15.31	12.13	18.12	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	22.04	20.20	12.96	-16.26	-15.02	14.84	21.63	21.72	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	23.57	20.39	11.03	-15.74	-12.08	14.56	24.03	20.89	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	25.95	21.79	10.42	-15.60	-10.99	12.92	24.91	21.36	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	28.27	21.74	8.90	-15.18	-10.61	12.96	27.76	22.09	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	29.51	21.46	8.28	-14.41	-8.49	12.87	29.65	21.69	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	33.01	19.45	5.63	-13.87	-6.90	12.34	33.33	20.06	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	34.75	19.54	4.92	-13.22	-6.41	11.26	34.08	20.38	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	35.72	20.08	4.31	-12.74	-6.09	11.51	35.99	19.85	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	37.04	19.34	3.10	-12.45	-5.25	10.01	37.23	19.27	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	40.22	18.14	1.66	-10.71	-4.30	10.33	40.24	18.30	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	41.51	18.25	0.90	-9.27	-3.46	10.03	41.56	17.19	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	41.60	17.59	0.96	-9.51	-2.54	10.38	41.72	17.53	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	43.32	17.48	0.23	-9.42	-1.84	9.14	41.98	17.14	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	42.80	17.55	0.24	-9.49	-0.87	8.98	42.11	17.08	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	31.69	15.49	-1.69	-6.74	1.67	20.11	43.16	16.12	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	44.16	17.16	-5.48	-16.01	2.13	10.23	37.68	19.88	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	44.90	13.55	-4.11	-2.22	-0.49	10.78	47.05	17.37	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	45.43	13.67	-0.09	-6.72	0.11	10.59	45.30	15.16	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	44.42	10.62	-1.44	-5.14	1.57	13.35	47.60	11.80	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 33. 0.10 mm zero preswirl $PR = 27\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	7.43	13.46	38.70	-17.67	-34.13	15.92	7.18	11.99	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	12.64	15.50	31.85	-21.93	-28.57	18.55	11.25	14.50	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	16.48	14.99	24.24	-22.90	-23.30	19.18	14.79	15.55	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	21.94	15.67	14.26	-18.93	-15.42	17.23	22.04	17.93	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	22.80	16.71	13.02	-17.78	-12.91	16.97	24.22	17.93	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	25.66	17.29	11.66	-17.88	-11.02	15.86	25.74	17.72	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	27.00	18.01	10.67	-17.00	-10.52	15.36	27.57	18.38	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	29.25	17.31	8.94	-17.00	-9.34	14.40	29.24	18.12	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	31.30	16.31	7.03	-15.12	-7.49	13.88	31.70	16.93	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	33.55	15.74	6.27	-15.44	-6.92	13.33	33.08	16.97	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	34.17	16.19	5.66	-14.79	-6.29	12.97	34.35	16.54	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	35.06	15.44	4.75	-14.17	-5.21	12.22	34.82	15.76	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	36.55	14.56	2.81	-12.15	-4.19	11.48	37.46	14.77	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	37.96	14.44	2.65	-11.68	-3.87	11.19	38.15	14.49	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	38.17	14.01	2.52	-10.95	-3.23	11.34	38.83	14.35	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	39.58	14.19	2.58	-10.75	-2.73	10.68	39.22	13.92	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	39.96	13.14	2.05	-10.32	-2.81	10.47	39.81	13.90	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	42.14	11.83	1.19	-9.27	-2.68	11.18	41.49	12.20	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	42.24	10.89	1.21	-7.95	-1.02	11.77	41.84	11.88	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	42.34	10.74	1.81	-7.85	-0.79	11.42	42.08	11.74	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	42.92	10.26	1.55	-9.21	-0.42	11.25	42.55	11.80	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	36.42	6.42	-1.65	-13.78	0.95	17.39	38.94	11.52	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 34. 0.10 mm zero preswirl $PR = 37\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	8.99	8.12	18.34	-5.40	-18.60	6.39	9.31	8.72	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	11.04	11.34	16.21	-6.75	-16.70	8.02	11.93	11.64	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	13.81	13.29	14.09	-7.53	-14.53	9.11	14.62	13.57	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	21.33	18.04	9.67	-9.04	-10.42	9.41	21.61	18.39	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	22.80	18.78	8.67	-9.26	-9.18	9.49	23.97	19.18	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	24.90	20.03	7.58	-8.98	-7.68	9.08	25.85	19.43	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	27.18	20.91	7.24	-8.53	-7.25	9.03	27.91	20.18	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	29.48	20.83	6.14	-9.37	-6.24	8.64	29.81	20.17	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	33.06	20.07	4.41	-8.44	-5.19	8.19	33.19	19.87	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	35.07	19.99	4.04	-8.78	-4.98	8.02	34.87	19.50	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	36.65	20.29	3.39	-8.60	-4.22	7.67	36.05	18.88	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	37.00	19.31	2.14	-7.42	-3.89	8.04	37.42	19.22	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	39.57	17.96	2.29	-6.81	-3.49	7.69	39.91	17.57	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	41.30	18.12	1.83	-6.72	-3.23	7.81	40.92	17.29	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	41.41	17.45	1.68	-6.35	-2.11	7.94	41.85	17.32	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	43.05	17.73	1.55	-6.04	-2.15	7.39	42.63	16.73	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	43.56	16.46	1.55	-5.78	-2.34	7.73	43.42	16.07	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	46.42	15.08	0.37	-5.31	-1.50	9.18	45.74	14.00	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	46.87	14.29	0.94	-3.61	-1.10	9.10	44.53	12.77	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	47.08	13.63	1.93	-3.42	-0.27	9.43	44.18	14.15	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	47.80	12.97	1.91	-4.63	-0.28	9.50	45.80	14.53	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	45.37	9.58	0.06	-3.56	5.42	12.67	50.16	11.82	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 35. 0.10 mm zero preswirl $PR = 37\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.57	11.71	26.66	-9.01	-26.31	10.50	7.58	10.20	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	9.57	14.09	23.62	-12.41	-23.22	11.58	9.88	13.07	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	12.44	10.12	20.28	-13.33	-20.54	16.15	13.48	15.48	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	21.12	19.41	13.81	-14.42	-14.37	13.64	20.67	19.67	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	22.68	20.37	12.23	-14.20	-12.03	13.29	23.04	19.86	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	25.13	21.36	11.04	-14.12	-10.74	12.62	25.18	20.08	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	27.22	21.52	10.00	-13.55	-10.13	12.42	26.89	20.47	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	29.22	21.58	8.86	-13.53	-8.78	12.63	29.72	21.13	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	32.68	19.90	6.19	-12.47	-6.91	11.93	32.78	19.41	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	34.52	20.27	5.99	-12.54	-6.35	11.54	34.34	19.79	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	36.02	19.93	5.27	-12.42	-5.84	11.40	35.73	19.28	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	37.49	19.17	3.89	-11.52	-4.99	10.40	36.61	18.49	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	39.68	18.05	2.87	-9.97	-4.23	10.24	39.97	17.41	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	41.37	18.37	2.54	-9.42	-3.47	9.95	40.88	17.24	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	41.29	17.42	2.44	-9.08	-2.51	10.13	41.54	16.86	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	42.90	17.99	2.16	-8.93	-2.18	9.51	42.20	16.19	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	43.69	17.62	1.57	-8.81	-1.19	9.42	42.34	16.17	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	39.39	18.45	2.50	-16.08	3.10	16.24	36.67	15.93	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	46.68	16.98	-5.63	-11.95	0.97	10.06	42.22	19.59	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	46.62	13.55	-0.52	-4.12	-0.05	11.73	45.54	15.62	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	47.27	12.91	1.00	-6.86	0.33	11.27	45.86	14.91	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	46.34	10.68	-0.65	-4.69	4.34	12.42	49.90	10.23	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 36. 0.10 mm zero preswirl $PR = 37\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.65	9.88	35.42	-11.49	-33.44	12.45	10.42	11.20	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	11.13	13.38	30.25	-15.83	-28.14	15.20	13.10	12.78	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	14.54	13.64	25.20	-17.09	-23.63	16.07	16.13	14.30	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	22.11	16.09	15.92	-16.13	-16.78	15.60	22.72	18.28	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	23.59	17.17	13.98	-16.23	-14.06	15.89	24.93	17.77	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	26.29	18.05	13.02	-16.03	-12.32	15.01	26.39	18.12	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	27.85	18.32	11.42	-15.59	-11.58	14.60	28.21	18.57	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	29.79	18.14	10.09	-15.50	-10.20	14.49	30.12	18.58	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	31.98	16.99	7.44	-13.94	-8.34	13.73	32.79	17.45	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	34.65	16.64	6.61	-14.54	-7.57	12.91	33.77	17.45	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	35.63	17.20	5.79	-14.05	-6.58	13.09	35.05	16.78	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	36.31	16.18	4.76	-13.00	-5.80	12.04	35.84	16.79	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	38.37	15.31	3.21	-11.82	-5.04	12.09	38.91	14.96	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	39.81	15.27	2.99	-11.39	-4.04	11.49	39.44	14.68	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	39.87	14.58	2.80	-10.56	-3.67	11.94	39.96	14.50	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	41.51	14.72	2.97	-10.46	-3.15	11.13	41.04	14.30	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	41.72	13.77	2.48	-10.04	-3.16	11.34	41.31	13.88	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	44.03	12.12	1.77	-8.68	-2.81	11.85	42.77	12.41	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	44.51	11.85	1.71	-7.91	-1.25	12.23	42.59	11.86	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	45.06	11.06	2.68	-7.94	-0.59	12.43	43.36	12.05	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	45.58	10.54	2.40	-8.92	-0.41	12.18	44.39	12.48	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	39.22	8.95	-2.11	-14.80	3.75	17.55	39.38	12.19	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 37. 0.10 mm zero preswirl $PR = 47\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	9.77	7.31	16.63	-5.52	-17.52	5.30	8.99	7.99	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	11.55	10.10	14.87	-6.90	-15.54	6.62	10.67	10.55	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	13.36	12.51	14.05	-7.33	-14.44	7.45	13.34	12.94	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	19.73	17.38	9.46	-8.72	-10.49	8.67	19.64	17.62	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	21.52	18.58	8.73	-9.04	-9.25	8.73	21.60	18.89	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	23.83	19.49	8.32	-9.20	-8.09	8.33	23.34	19.52	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	25.60	20.46	7.49	-9.06	-7.26	8.19	25.51	19.62	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	27.96	20.80	6.60	-9.34	-6.63	8.48	27.92	20.41	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	31.12	19.81	5.05	-8.56	-5.57	8.52	31.05	19.97	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	32.99	19.86	4.44	-8.30	-5.10	8.01	32.49	19.99	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	34.26	19.47	3.78	-8.03	-4.57	8.12	34.15	19.52	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	36.26	18.57	3.66	-8.18	-4.18	7.17	34.72	18.81	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	38.43	18.05	2.28	-7.09	-2.86	7.35	38.45	18.24	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	40.58	18.58	1.88	-6.98	-2.93	6.89	39.20	17.76	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	40.82	17.32	2.01	-6.70	-2.25	7.67	40.09	17.45	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	42.10	17.51	1.85	-6.42	-2.27	7.30	40.89	16.79	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	42.49	16.57	1.73	-6.04	-2.07	7.07	41.44	16.75	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	45.15	15.05	1.04	-5.64	-1.53	8.72	44.16	15.01	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	45.51	13.88	0.75	-4.40	-0.64	8.59	43.19	14.29	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	45.72	13.95	1.58	-4.15	-0.09	8.83	44.01	14.58	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	46.24	13.19	1.62	-5.08	-0.31	8.67	44.70	14.64	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	46.74	12.71	-0.51	-3.23	3.92	9.08	49.62	10.99	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 38. 0.10 mm zero preswirl $PR = 47\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	6.12	8.80	24.18	-7.24	-24.72	7.90	8.06	9.06	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	8.93	12.53	22.51	-9.19	-22.05	9.44	9.94	11.91	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	12.20	13.64	19.46	-10.58	-20.30	11.55	13.18	14.45	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	19.74	18.55	14.14	-12.62	-14.82	12.46	19.81	18.98	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	21.52	19.71	12.44	-12.60	-12.56	13.00	22.34	19.00	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	23.96	20.81	11.62	-12.77	-11.03	11.91	23.77	19.30	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	26.03	20.88	10.21	-12.13	-10.48	11.89	25.76	20.14	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	27.79	21.02	9.19	-12.66	-8.85	12.08	27.89	20.26	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	31.73	19.89	7.47	-11.78	-7.31	11.88	31.53	19.62	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	33.89	19.99	6.39	-12.64	-6.72	10.97	32.32	19.67	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	34.79	19.59	5.64	-12.12	-6.50	10.97	34.09	19.59	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	36.48	19.66	4.99	-11.52	-5.27	10.00	35.01	19.10	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	38.47	18.02	3.50	-10.43	-4.70	10.33	38.80	17.93	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	41.23	18.77	2.83	-10.30	-3.75	9.95	39.42	17.73	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	41.49	17.42	2.94	-10.00	-3.01	10.30	40.14	16.99	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	42.66	17.85	2.57	-9.63	-2.22	9.51	40.81	16.63	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	43.07	17.06	2.38	-9.56	-2.08	9.64	41.28	16.47	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	38.67	19.39	1.69	-18.65	4.68	15.91	35.33	17.80	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	46.80	15.59	-3.74	-9.22	0.27	10.18	43.41	17.25	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	45.91	13.24	0.49	-5.69	-0.10	11.47	43.93	15.33	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	46.11	13.31	1.31	-7.57	0.55	11.02	45.13	14.72	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	46.65	12.58	-1.33	-5.34	3.40	10.73	48.96	10.91	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 39. 0.10 mm zero preswirl $PR = 47\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	8.98	9.99	30.98	-10.35	-30.90	11.10	11.01	8.97	1.119	0.913	0.222	1.350	0.117	0.217	0.172	0.121
30	12.33	12.69	27.93	-13.04	-27.70	13.10	12.66	11.86	1.250	0.952	0.217	1.734	0.170	0.207	0.199	0.215
40	15.30	13.93	23.93	-14.65	-23.90	15.10	15.85	13.72	1.751	0.786	0.346	2.530	0.325	0.328	0.203	0.270
70	22.96	17.34	16.84	-16.33	-17.85	16.07	23.45	18.16	1.143	0.491	0.579	2.452	0.205	0.210	0.323	0.338
80	23.83	18.25	14.79	-15.30	-14.73	16.14	25.56	17.76	0.644	0.238	0.279	1.391	0.248	0.094	0.190	0.208
90	26.60	18.87	13.62	-15.64	-13.24	15.37	26.79	18.00	0.572	0.246	0.271	1.372	0.149	0.234	0.242	0.223
100	27.96	19.31	12.58	-15.04	-12.96	15.00	28.48	18.93	0.440	0.226	0.299	1.186	0.124	0.128	0.313	0.242
110	30.05	18.91	10.79	-15.35	-10.79	15.37	30.30	18.48	0.594	0.129	0.206	1.321	0.132	0.195	0.210	0.158
130	33.26	18.09	8.61	-14.44	-8.70	14.96	33.38	18.34	0.368	0.201	0.303	1.047	0.144	0.097	0.171	0.302
140	35.06	17.77	7.49	-14.30	-8.18	13.96	34.55	18.13	0.370	0.126	0.216	1.065	0.089	0.177	0.283	0.175
150	36.45	17.73	7.02	-14.19	-6.95	14.30	36.31	17.48	0.387	0.153	0.206	0.770	0.246	0.232	0.225	0.195
160	37.66	17.19	6.22	-13.74	-6.08	12.74	36.89	17.23	0.174	0.219	0.378	0.533	0.084	0.198	0.226	0.186
190	38.94	16.08	4.44	-12.54	-4.94	12.76	40.14	15.91	0.189	0.143	0.271	0.162	0.150	0.083	0.071	0.221
200	41.23	16.38	4.07	-12.28	-4.06	12.02	40.76	15.09	0.163	0.131	0.371	0.209	0.122	0.130	0.126	0.290
210	41.48	15.46	3.67	-11.93	-3.03	11.99	41.23	14.69	0.123	0.144	0.238	0.152	0.084	0.079	0.101	0.200
220	43.11	15.39	3.47	-11.59	-2.80	11.33	41.44	14.43	0.103	0.284	0.183	0.207	0.127	0.152	0.132	0.251
230	43.07	14.32	2.89	-11.40	-3.30	11.17	42.29	14.51	0.198	0.160	0.186	0.153	0.155	0.132	0.136	0.310
260	46.24	12.50	0.87	-10.06	-3.00	12.62	44.79	12.38	0.470	0.618	0.768	0.616	0.512	0.589	0.792	0.762
270	46.15	12.01	0.99	-9.21	-1.25	12.82	43.17	12.38	0.382	0.250	0.782	0.840	0.291	0.221	0.644	0.443
280	46.09	11.00	2.54	-7.75	-1.05	12.64	44.09	12.75	0.286	0.269	0.389	0.454	0.159	0.166	0.352	0.322
290	46.55	10.94	2.02	-9.24	-0.87	12.72	45.17	12.83	0.153	0.219	0.175	0.250	0.224	0.223	0.100	0.206
330	39.57	12.08	-4.06	-12.64	6.34	18.11	44.81	13.14	0.264	0.455	0.271	0.255	0.254	0.377	0.244	0.367

Table 40. 0.20 mm high preswirl $PR = 17\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.95	6.00	21.64	-3.69	-24.20	3.46	-2.74	5.80	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	-0.39	7.96	20.82	-5.05	-22.86	4.80	-1.17	8.84	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	0.65	9.79	19.87	-6.52	-21.47	6.40	0.72	10.68	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	4.18	13.14	15.58	-6.83	-20.88	7.55	5.28	18.55	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	6.38	16.03	16.02	-8.77	-17.04	9.10	7.19	16.44	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	7.89	17.06	15.30	-8.81	-16.47	9.05	8.53	17.71	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	9.84	18.00	14.44	-9.62	-15.40	8.95	9.83	18.25	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	10.85	18.54	13.71	-9.52	-14.67	9.13	11.11	18.79	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	13.56	20.14	12.57	-9.51	-13.32	10.19	14.66	20.12	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	14.50	20.08	11.72	-9.39	-13.34	10.11	16.11	20.69	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	16.43	19.97	10.62	-9.47	-12.46	9.95	17.49	20.91	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	18.02	20.73	10.88	-9.56	-12.47	10.02	18.79	20.97	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	21.44	20.82	8.93	-9.01	-10.89	10.02	22.18	21.72	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	22.84	21.73	8.50	-9.24	-9.29	10.46	22.63	22.07	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	23.49	21.64	8.28	-9.43	-8.59	10.66	23.64	21.62	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	24.91	21.97	7.97	-9.17	-8.66	10.71	24.68	21.81	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	25.98	21.82	7.46	-8.76	-8.13	10.66	26.06	21.72	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	29.89	20.11	7.66	-6.67	-6.39	12.75	30.36	21.09	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	31.08	20.41	7.35	-8.26	-6.50	13.15	31.43	21.01	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	32.63	18.03	5.49	-7.80	-1.18	17.46	34.93	19.63	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 41. 0.20 mm high preswirl $PR = 17\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.81	6.32	24.20	-4.43	-26.54	4.04	-2.80	5.87	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	-0.07	8.49	23.09	-6.41	-25.11	6.16	-1.17	8.98	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	0.16	8.91	21.81	-7.40	-23.58	7.95	0.74	11.29	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	5.27	14.61	18.13	-9.52	-19.69	10.00	5.92	15.34	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	6.39	15.78	16.91	-9.51	-18.61	9.81	6.88	16.77	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	8.33	17.19	16.55	-10.11	-17.97	10.25	8.70	17.87	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	10.02	17.97	15.40	-10.60	-16.23	10.50	10.17	17.81	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	11.16	18.53	14.68	-10.42	-16.43	10.66	12.15	19.65	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	14.47	19.66	13.33	-11.17	-14.29	11.05	14.69	19.91	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	15.01	19.57	12.43	-10.26	-14.61	11.13	16.52	21.18	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	17.04	20.30	12.16	-10.96	-13.09	10.91	17.30	20.42	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	18.31	20.64	11.20	-11.43	-12.61	11.52	18.84	20.54	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	21.52	20.41	9.13	-10.77	-11.41	11.21	21.92	21.18	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	22.61	21.10	8.73	-10.47	-9.93	11.74	22.99	21.45	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	22.99	21.31	8.29	-10.10	-9.28	12.02	24.20	21.62	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	25.00	22.19	8.46	-10.30	-8.73	11.54	25.03	21.45	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	26.24	21.82	7.10	-10.13	-8.28	11.35	26.00	21.71	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	30.07	19.42	5.82	-5.91	-6.87	13.28	31.93	22.58	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	31.57	19.55	7.14	-8.76	-7.28	13.69	32.25	20.92	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	33.81	18.15	5.84	-7.37	-0.49	16.53	37.27	17.76	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 42. 0.20 mm high preswirl $PR = 17\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-2.04	6.82	27.27	-5.25	-29.42	4.90	-2.89	6.63	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	-0.38	9.07	26.04	-7.46	-27.53	6.73	-1.66	9.01	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	1.02	10.77	24.03	-9.06	-26.16	9.18	1.21	11.48	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	4.99	15.43	19.96	-10.46	-21.69	10.73	5.43	16.19	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	7.24	16.17	18.11	-11.48	-20.36	11.44	7.36	17.37	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	9.06	17.86	17.66	-11.98	-18.93	11.76	9.11	18.10	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	10.21	18.49	16.37	-11.79	-17.54	12.11	10.88	18.58	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	11.89	19.63	15.90	-11.74	-17.35	12.15	12.77	20.15	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	14.26	19.75	14.09	-11.37	-15.30	12.91	16.32	19.76	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	16.08	19.71	13.56	-12.03	-15.35	12.56	17.06	20.65	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	17.15	20.37	12.91	-11.94	-14.01	12.50	18.11	20.56	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	19.08	20.53	12.13	-12.57	-13.29	12.61	19.44	20.47	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	22.50	19.92	9.78	-11.99	-11.46	12.86	22.70	20.34	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	23.51	20.78	9.34	-11.84	-10.19	12.92	23.51	20.64	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	23.84	21.05	9.01	-11.85	-9.76	12.88	24.62	20.94	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	26.07	21.26	8.65	-11.57	-9.33	12.46	25.44	21.00	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	26.77	20.62	7.83	-11.29	-8.86	12.55	26.32	21.18	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
260	29.46	20.08	6.37	-10.01	-8.47	13.95	30.21	19.54	0.814	1.349	1.049	3.142	1.482	0.715	2.899	1.286
270	29.76	19.15	6.25	-8.39	-7.14	14.64	30.26	19.73	2.785	2.666	3.486	5.973	2.208	1.906	4.801	2.183
280	31.06	19.49	7.99	-9.29	-6.13	13.82	30.70	20.07	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	32.52	19.40	8.16	-10.00	-6.32	13.62	32.69	19.76	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365

Table 43. 0.20 mm high preswirl $PR = 27\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.41	4.75	21.00	-3.28	-22.19	3.15	2.75	5.37	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	3.94	7.04	20.49	-4.84	-20.46	5.28	3.90	6.97	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	4.63	9.49	20.07	-5.82	-19.27	5.79	4.02	9.20	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.09	12.99	16.79	-7.32	-16.63	7.22	8.37	14.52	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	9.59	14.74	16.42	-8.15	-15.45	7.96	10.08	15.66	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	10.70	16.20	16.08	-8.37	-14.71	7.43	10.91	16.97	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	12.39	16.99	14.91	-9.07	-14.47	7.03	12.20	17.96	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	13.39	17.50	13.83	-8.88	-14.06	7.66	14.20	18.80	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	17.23	18.81	12.79	-9.81	-12.06	8.50	17.04	19.32	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	17.44	18.62	11.34	-9.24	-12.88	8.41	18.17	20.27	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.45	18.37	10.66	-9.68	-11.45	8.35	20.05	19.90	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	20.46	21.42	12.68	-9.85	-10.69	8.21	20.01	19.16	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	23.82	19.61	8.91	-9.23	-9.90	8.72	24.16	20.86	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	25.07	20.82	8.54	-8.96	-9.10	9.33	24.87	21.31	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	25.47	21.18	8.93	-9.03	-8.33	9.34	25.80	21.19	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	27.00	21.35	8.24	-9.15	-8.47	9.63	27.01	21.18	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	27.79	21.04	8.02	-8.59	-8.24	10.50	28.95	21.90	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	32.43	20.00	7.70	-6.91	-5.94	12.38	32.90	20.73	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	33.10	19.99	7.50	-7.86	-6.45	12.45	33.84	20.92	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	34.16	18.64	5.01	-6.78	-0.25	14.76	38.30	17.78	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 44. 0.20 mm high preswirl $PR = 27\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.60	5.17	23.49	-4.29	-24.75	3.89	1.95	5.48	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	3.64	7.21	23.29	-6.05	-23.58	6.26	3.19	7.34	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	4.15	8.73	22.50	-7.17	-20.87	7.77	4.06	9.88	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.35	13.12	18.84	-8.08	-18.67	9.04	8.91	15.22	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	9.64	14.89	18.60	-9.07	-17.09	9.14	10.29	15.92	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	11.33	15.75	16.83	-10.22	-16.25	8.93	11.43	17.13	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	13.21	16.79	15.74	-10.99	-15.40	8.85	13.00	17.81	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	14.34	17.13	14.54	-11.24	-15.31	8.69	14.01	18.85	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	17.41	19.09	14.08	-11.46	-13.47	9.79	17.60	19.13	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	17.98	18.75	12.55	-10.99	-13.29	10.08	18.82	19.74	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	20.05	19.01	12.32	-11.51	-11.70	9.60	19.77	19.15	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	20.48	19.35	11.25	-11.19	-11.70	10.30	20.96	19.57	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	24.20	18.84	9.21	-10.79	-10.08	9.21	24.17	20.43	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	25.17	20.42	9.70	-10.74	-9.46	10.03	24.81	20.49	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	26.12	20.60	9.16	-11.03	-8.51	10.79	26.22	20.69	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	27.07	20.36	7.79	-10.19	-9.21	10.64	27.10	21.80	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	27.93	19.77	7.39	-10.25	-8.33	10.82	28.44	21.55	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	31.62	18.82	9.50	-5.75	-6.33	13.26	34.42	19.16	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	32.70	19.28	7.90	-9.04	-6.24	12.63	34.21	20.22	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	35.50	16.47	4.76	-8.68	-0.71	15.49	38.36	17.70	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 45. 0.20 mm high preswirl $PR = 27\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.09	4.49	26.29	-4.67	-28.73	5.58	1.19	5.48	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	3.53	7.58	25.44	-6.73	-26.22	6.49	1.75	8.28	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	4.38	10.05	24.47	-8.36	-24.09	8.99	3.62	9.94	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.53	14.02	20.41	-10.52	-20.40	11.41	9.54	14.39	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	9.63	15.61	19.70	-10.40	-19.24	10.86	10.35	16.51	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	10.93	15.87	17.39	-10.46	-19.33	10.99	11.97	19.11	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	13.84	16.93	15.85	-12.64	-17.40	9.69	12.14	19.27	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	15.05	18.08	15.72	-13.10	-16.87	10.35	14.18	19.74	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	18.26	18.97	14.17	-13.06	-14.68	11.37	17.16	20.30	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	19.41	18.35	13.50	-13.43	-14.62	10.76	17.85	20.02	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	21.23	18.64	12.45	-13.49	-13.42	10.95	19.84	20.04	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	20.80	19.67	12.07	-12.59	-13.39	12.40	21.41	20.82	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	24.71	18.84	9.79	-12.16	-11.48	10.94	23.95	20.57	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	25.82	20.11	9.75	-11.89	-9.77	12.28	25.87	20.26	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	26.50	20.33	9.36	-11.93	-9.29	12.15	26.59	20.74	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	27.28	20.33	8.64	-11.59	-9.51	11.69	27.33	20.92	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	28.50	19.96	8.03	-11.34	-8.98	12.09	28.40	21.20	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	33.15	19.23	7.76	-9.52	-6.63	12.88	33.62	21.41	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	34.20	18.94	8.02	-10.80	-6.13	13.16	34.65	19.49	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365

Table 46. 0.20 mm high preswirl $PR = 37\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.09	4.11	18.98	-2.63	-19.73	2.47	4.57	4.63	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	4.74	6.01	18.35	-3.70	-18.89	4.13	5.23	6.01	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	6.06	8.15	18.14	-4.89	-18.26	5.01	6.45	8.06	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.56	12.66	16.15	-6.52	-15.82	6.22	9.50	12.70	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	9.39	14.06	15.65	-6.87	-14.96	6.65	10.54	13.96	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	10.81	15.28	14.84	-7.65	-14.52	6.64	11.58	15.55	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	12.12	16.52	14.13	-7.66	-14.10	6.93	12.86	16.13	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	13.56	17.36	13.47	-8.53	-13.36	7.11	14.59	17.39	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	16.13	18.67	12.14	-8.17	-12.89	7.52	16.65	18.63	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	17.33	18.60	11.42	-8.92	-12.57	7.91	18.51	19.12	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.28	18.48	10.69	-8.77	-11.61	8.23	19.66	18.59	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	20.87	19.41	11.57	-7.61	-11.66	7.82	22.00	18.22	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	23.96	20.94	10.11	-8.00	-9.79	7.49	23.69	19.64	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	25.50	21.88	9.60	-8.68	-9.17	8.63	24.25	20.48	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	26.16	21.25	8.71	-8.85	-8.64	9.09	25.32	21.38	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	26.67	21.25	8.09	-8.34	-8.82	9.18	26.80	21.82	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	28.20	21.63	7.88	-8.70	-7.89	9.91	27.92	21.36	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	31.99	20.84	7.59	-6.11	-6.20	11.92	33.47	22.03	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	33.64	21.05	7.79	-7.77	-6.96	12.00	33.50	22.09	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	36.29	18.79	5.24	-6.90	-0.71	15.28	39.11	18.78	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 47. 0.20 mm high preswirl $PR = 37\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.47	4.46	21.23	-2.90	-23.25	3.43	4.11	4.75	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	4.77	6.44	20.59	-4.54	-21.88	4.53	5.03	6.82	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
70	8.57	12.78	17.91	-7.18	-18.15	8.03	9.90	13.61	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	9.86	14.49	17.24	-8.09	-16.63	8.28	10.80	14.57	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	11.33	15.68	16.15	-8.82	-15.99	8.33	11.93	15.63	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	12.47	16.57	15.60	-9.15	-15.14	7.86	12.72	16.68	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	13.68	17.28	14.21	-9.60	-15.10	8.18	14.16	17.63	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	17.40	18.52	13.06	-10.02	-13.47	8.90	17.52	18.56	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	17.45	18.85	12.75	-9.24	-13.30	9.36	18.95	18.60	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.42	18.84	11.37	-10.23	-12.37	9.24	19.73	18.89	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	20.72	20.08	11.30	-10.06	-12.37	9.51	21.01	19.93	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	23.72	19.57	9.07	-9.65	-10.98	9.03	23.87	20.51	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	24.94	21.32	9.47	-9.12	-9.85	9.86	24.68	20.90	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	25.52	21.16	8.97	-9.43	-8.94	11.03	26.14	21.29	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	27.36	21.60	8.37	-9.30	-7.65	9.85	27.80	20.45	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	28.98	22.04	7.50	-10.26	-8.23	10.22	27.76	22.32	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	33.51	20.61	7.20	-6.56	-6.10	12.66	34.03	22.31	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	34.63	20.69	8.12	-8.90	-6.42	12.52	34.65	21.11	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	37.29	17.85	5.66	-8.62	-0.55	16.20	39.86	18.94	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 48. 0.20 mm high preswirl $PR = 37\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.16	5.28	24.46	-3.72	-26.41	3.57	3.09	5.00	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	3.86	7.20	23.77	-5.44	-25.22	5.92	4.00	6.90	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	5.16	7.71	22.48	-6.36	-23.27	6.64	5.13	8.65	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.22	13.73	19.92	-8.08	-21.09	10.08	10.10	14.32	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	10.33	15.06	18.65	-9.31	-19.76	9.89	11.27	15.91	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	11.74	16.36	17.72	-9.97	-18.54	9.54	11.84	17.41	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	12.66	17.50	16.60	-10.14	-17.02	9.74	13.25	17.72	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	14.71	17.90	14.79	-10.77	-17.71	9.88	15.16	20.55	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	18.03	19.30	14.67	-11.08	-14.83	10.75	18.08	18.57	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	18.43	19.43	13.80	-11.15	-15.03	11.43	19.61	19.54	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.72	20.13	13.43	-10.90	-13.83	10.63	20.28	19.64	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	21.13	20.72	12.66	-11.25	-13.37	11.83	22.38	20.35	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	24.43	20.85	10.15	-10.87	-11.79	11.47	25.15	20.91	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	26.39	21.59	10.50	-11.48	-10.70	12.01	26.22	21.23	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	26.94	21.58	9.70	-11.19	-10.06	12.65	26.91	21.37	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	28.02	21.61	9.11	-11.04	-10.04	11.73	27.74	22.03	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	28.76	21.71	8.79	-10.29	-9.29	12.88	29.59	21.32	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	34.30	20.44	7.59	-8.46	-7.04	13.77	34.55	22.21	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	35.26	20.33	8.22	-10.77	-7.28	14.69	35.64	21.36	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365

Table 49. 0.20 mm high preswirl $PR = 47\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.30	4.02	16.95	-2.02	-17.40	2.26	5.56	4.16	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	5.59	5.89	16.86	-2.79	-16.69	3.01	5.97	5.69	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	6.65	7.41	16.61	-3.44	-16.26	3.94	6.89	7.30	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.79	12.16	14.81	-4.80	-15.06	5.12	10.29	12.63	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	9.86	14.02	14.88	-5.23	-13.89	5.71	10.96	13.55	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	10.63	15.39	14.75	-5.43	-13.30	5.60	11.63	14.83	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	11.98	16.41	13.97	-6.04	-12.64	5.76	13.22	15.93	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	13.64	17.07	13.03	-7.03	-12.78	5.73	14.21	17.34	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	16.16	19.13	12.85	-7.24	-12.20	6.38	16.41	18.94	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	17.13	19.64	12.46	-7.38	-11.92	6.68	17.75	19.21	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.06	19.76	11.28	-7.55	-10.82	5.96	18.69	19.39	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	19.56	20.98	11.40	-7.79	-10.96	6.90	20.07	19.86	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	22.23	21.24	9.31	-7.23	-9.38	7.62	24.31	21.96	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	24.19	23.00	9.72	-7.43	-8.25	7.98	24.97	21.32	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	25.51	23.77	10.00	-8.29	-8.33	8.24	25.85	22.08	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	27.43	23.97	9.41	-8.38	-8.12	8.05	26.92	21.98	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	28.53	23.84	8.80	-8.10	-7.97	8.16	28.30	22.42	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	33.30	23.56	8.39	-6.75	-6.58	9.99	32.58	22.18	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	35.25	23.72	8.60	-7.99	-6.80	9.88	33.21	22.77	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	40.79	22.71	6.74	-8.36	-4.99	12.59	38.28	22.47	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 50. 0.20 mm high preswirl $PR = 47\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.48	3.75	19.38	-2.33	-19.93	2.56	5.57	4.43	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	5.83	5.65	18.91	-3.17	-18.69	3.37	6.29	6.15	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	7.06	7.11	18.85	-3.87	-19.01	4.48	7.18	8.09	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	8.60	12.34	17.04	-5.48	-16.95	6.07	10.33	13.02	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	10.66	13.89	16.26	-6.90	-15.84	6.80	11.44	13.65	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	12.33	15.26	15.90	-7.77	-15.04	6.77	11.88	14.93	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	12.90	16.60	15.24	-7.69	-14.38	6.46	13.48	16.23	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	13.89	17.80	14.77	-7.56	-14.25	6.80	14.53	17.14	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	17.51	18.84	13.83	-8.40	-12.80	7.64	17.49	18.00	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	17.54	18.89	13.05	-8.25	-12.64	7.86	18.27	18.68	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.71	19.34	12.17	-9.29	-12.03	7.49	19.66	19.12	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	20.86	20.64	11.81	-9.23	-11.87	8.55	21.33	20.30	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	24.55	21.51	10.42	-9.55	-10.25	7.75	24.29	21.07	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	26.10	23.27	10.40	-9.38	-9.85	8.82	25.83	21.95	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	26.49	23.27	9.99	-9.54	-8.87	9.51	26.88	22.05	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	27.76	24.54	8.84	-9.40	-7.55	9.24	27.66	22.17	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	29.41	24.99	8.06	-11.76	-6.73	8.83	26.53	23.27	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
290	35.46	25.51	7.43	-8.81	-5.52	11.25	35.20	22.84	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365
330	40.61	21.55	5.69	-9.68	-5.07	13.62	39.76	21.38	0.627	0.826	0.460	0.490	0.822	0.593	0.709	0.616

Table 51. 0.20 mm high preswirl $PR = 47\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.06	4.33	21.62	-2.88	-22.88	2.71	5.43	4.27	0.186	0.152	0.205	0.164	0.342	0.196	0.185	0.242
30	5.68	6.15	20.93	-4.08	-21.56	3.82	5.23	5.98	0.211	0.159	0.207	0.196	0.263	0.141	0.158	0.141
40	7.17	7.17	19.78	-4.81	-20.64	5.24	6.64	7.96	0.406	0.355	0.193	0.214	0.422	0.383	0.124	0.298
70	10.30	12.77	18.10	-7.72	-18.25	7.23	10.40	12.84	0.267	0.096	0.190	0.221	0.224	0.226	0.242	0.266
80	11.23	13.76	17.42	-7.57	-17.69	7.54	11.31	13.97	0.216	0.137	0.129	0.173	0.196	0.262	0.245	0.235
90	12.40	15.87	17.61	-8.11	-17.17	7.90	12.38	15.93	0.293	0.203	0.164	0.239	0.342	0.175	0.210	0.375
100	13.22	16.54	15.84	-8.26	-16.11	8.37	14.02	16.89	0.327	0.245	0.179	0.236	0.112	0.149	0.356	0.209
110	14.46	17.78	15.77	-8.69	-16.13	8.76	15.39	17.78	0.293	0.187	0.331	0.251	0.154	0.181	0.276	0.180
130	17.39	18.64	14.29	-9.43	-14.27	9.54	17.60	18.25	0.362	0.325	0.344	0.356	0.359	0.301	0.418	0.332
140	18.45	18.88	13.27	-9.75	-14.51	9.36	18.59	19.48	0.255	0.212	0.214	0.274	0.204	0.237	0.277	0.179
150	19.46	19.85	13.05	-10.06	-13.25	9.50	19.63	19.52	0.189	0.253	0.187	0.143	0.303	0.219	0.197	0.325
160	21.22	20.34	12.92	-10.55	-12.92	10.02	21.04	20.11	0.289	0.237	0.193	0.246	0.228	0.232	0.357	0.327
190	24.38	20.95	10.53	-10.49	-11.64	10.60	25.08	21.48	0.224	0.324	0.181	0.138	0.300	0.360	0.390	0.348
200	26.09	22.23	10.98	-10.31	-10.13	10.71	26.18	21.07	0.344	0.383	0.252	0.301	0.203	0.261	0.428	0.339
210	26.44	22.34	9.89	-10.85	-9.99	10.88	26.81	22.00	0.339	0.314	0.218	0.197	0.222	0.190	0.367	0.251
220	28.36	22.74	9.57	-10.28	-9.88	10.68	27.67	22.01	0.294	0.396	0.280	0.245	0.380	0.335	0.431	0.282
230	29.39	22.19	8.94	-10.51	-9.39	11.28	29.10	22.00	0.459	0.582	0.262	0.627	0.558	0.424	0.671	0.384
280	35.52	21.62	8.19	-8.55	-7.55	12.64	34.16	23.01	0.537	0.801	1.469	1.266	0.666	0.407	0.755	0.899
290	36.34	20.97	7.84	-10.09	-8.36	13.93	35.07	22.74	0.635	0.918	0.343	0.417	0.605	0.561	0.413	0.365

Table 52. 0.20 mm medium preswirl $PR = 17\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.01	5.76	17.63	-3.31	-19.82	3.39	-1.17	5.92	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	0.25	8.21	16.95	-4.52	-18.95	4.84	0.14	8.61	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	1.68	10.09	16.14	-5.70	-18.04	6.16	1.46	10.54	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	6.57	15.03	13.35	-7.49	-15.28	7.44	5.84	15.86	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	8.03	16.07	12.47	-7.62	-14.40	7.80	7.47	17.05	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	9.08	17.37	12.22	-7.51	-13.71	8.43	9.22	18.06	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	10.82	18.34	11.50	-8.06	-12.53	8.57	10.75	18.77	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	12.19	18.83	10.83	-7.94	-11.78	8.68	12.03	19.36	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	15.02	19.71	9.86	-8.36	-10.04	9.31	15.02	20.37	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	15.57	20.34	9.15	-7.92	-10.21	9.42	16.86	21.39	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	16.87	20.18	8.07	-7.86	-8.92	9.22	17.89	21.34	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	18.46	21.10	8.44	-7.66	-8.88	9.79	19.97	21.48	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	21.98	21.05	6.86	-8.03	-6.59	8.93	22.59	21.68	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	23.90	21.58	6.55	-7.86	-6.11	9.62	23.96	21.88	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	24.79	22.06	6.40	-7.71	-5.36	9.70	25.22	21.72	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	26.44	21.74	6.11	-7.62	-5.23	9.50	26.12	21.75	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	27.37	21.50	5.43	-7.55	-4.18	8.99	27.04	21.50	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	31.49	19.86	6.10	-5.39	-1.51	10.13	30.54	18.80	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	32.73	19.73	5.60	-6.76	-1.10	8.96	30.08	19.25	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	33.76	19.40	4.09	-4.77	-2.50	9.36	29.69	19.71	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 53. 0.20 mm medium preswirl $PR = 17\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.15	5.81	19.82	-3.98	-23.34	4.16	-1.28	6.34	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	0.19	8.57	19.04	-5.29	-21.86	5.66	-0.08	8.87	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	0.90	9.79	18.48	-6.31	-20.14	7.66	1.44	11.08	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	6.63	15.10	14.81	-8.37	-17.01	8.63	5.71	16.00	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	8.23	16.01	13.81	-8.72	-16.02	9.55	8.00	17.25	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	9.52	17.59	13.52	-8.87	-15.33	9.80	9.55	18.30	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	11.05	18.15	12.26	-8.97	-13.98	10.01	11.11	18.89	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	12.26	18.81	11.89	-8.97	-13.44	10.32	12.74	19.71	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	15.09	20.12	11.07	-9.07	-11.87	11.34	15.90	21.27	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	15.90	20.42	10.05	-8.86	-10.93	11.10	17.68	21.03	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	17.43	20.58	9.26	-9.03	-9.76	10.39	18.37	21.19	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	19.58	21.64	9.26	-9.54	-9.40	11.19	20.00	21.65	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	22.46	21.57	7.77	-9.00	-6.86	10.58	23.30	21.44	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	24.30	21.73	7.44	-8.64	-6.61	11.18	25.01	21.59	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	25.59	22.01	6.91	-9.04	-5.92	10.98	25.47	21.69	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	27.46	22.16	6.15	-8.87	-4.94	10.66	26.51	21.74	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	28.89	21.66	5.73	-9.39	-4.07	9.24	26.97	21.81	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	32.40	20.56	6.42	-5.70	-1.11	10.66	31.70	18.60	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	33.17	19.95	6.19	-7.81	-0.67	9.87	31.08	18.63	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	33.70	18.62	3.66	-6.41	-2.11	10.16	30.65	19.54	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 54. 0.20 mm medium preswirl $PR = 17\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.83	6.47	24.00	-4.85	-27.47	5.62	-1.60	7.19	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	-0.20	9.56	23.05	-6.67	-25.71	7.51	-0.28	9.86	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	1.36	11.67	21.57	-8.17	-24.03	8.91	1.43	11.68	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	7.16	16.34	17.42	-10.69	-18.89	10.56	6.04	16.43	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	8.76	17.32	16.35	-10.92	-18.05	10.87	7.93	18.08	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	10.15	18.57	15.63	-10.85	-16.80	11.19	9.79	18.91	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	11.97	19.04	14.19	-11.25	-15.57	11.74	11.59	19.56	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	13.21	19.46	13.45	-11.11	-14.57	11.86	13.21	20.28	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	15.65	20.64	12.08	-11.05	-14.37	12.74	16.67	21.92	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	17.08	21.17	11.38	-10.86	-12.01	11.83	17.69	22.06	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	18.45	21.33	10.74	-10.90	-9.71	12.41	19.21	21.09	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	20.71	21.96	10.14	-11.38	-10.95	12.48	20.93	22.28	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	23.66	21.05	8.21	-10.84	-7.31	12.49	24.36	21.53	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	25.94	21.22	7.24	-10.50	-7.34	12.40	26.11	21.93	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	27.39	21.96	7.27	-10.85	-6.80	12.05	26.46	22.00	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	28.49	20.75	6.73	-10.21	-6.15	12.06	27.91	21.69	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	29.02	20.87	6.21	-9.76	-5.56	11.57	28.99	21.69	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	33.05	19.50	6.91	-8.35	-2.22	11.59	32.05	18.40	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	33.88	18.71	6.12	-9.76	-1.91	11.02	31.70	19.05	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315

Table 55. 0.20 mm medium preswirl $PR = 27\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.49	5.03	17.45	-3.26	-19.52	3.39	1.36	5.54	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	3.16	7.23	16.64	-4.36	-18.77	4.67	2.36	8.25	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	4.30	9.25	16.02	-4.74	-17.89	5.69	3.84	10.16	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	8.59	13.92	13.23	-7.00	-15.07	7.37	8.07	15.37	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	10.11	15.46	12.66	-7.58	-14.31	7.50	9.09	16.72	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	11.16	16.62	12.23	-7.50	-13.73	7.71	10.45	18.16	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	12.59	17.63	11.62	-7.76	-12.68	7.92	12.55	18.76	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	13.97	18.06	10.79	-7.85	-12.13	8.52	14.24	19.55	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	17.15	19.20	9.78	-8.40	-10.45	8.59	16.57	20.57	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	17.74	19.69	9.17	-8.24	-10.01	9.24	18.69	20.85	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	19.70	19.43	8.13	-8.47	-9.04	8.87	19.74	21.15	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	20.76	20.82	7.88	-7.84	-8.25	9.02	20.61	21.19	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	24.38	20.50	7.01	-7.94	-6.35	9.09	24.48	21.62	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	26.11	21.50	6.94	-7.45	-5.98	9.49	25.94	21.39	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	26.82	21.78	6.89	-7.83	-5.32	9.54	26.92	21.67	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	28.59	21.29	6.18	-7.98	-5.01	9.17	27.50	21.65	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	29.12	21.39	5.96	-7.65	-4.37	9.09	28.37	21.78	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	33.86	19.56	5.94	-5.50	-1.55	9.96	32.73	19.61	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	35.24	19.42	5.65	-7.24	-1.12	8.87	32.30	19.56	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	36.71	16.89	2.60	-5.93	-1.33	10.01	33.47	20.40	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 56. 0.20 mm medium preswirl $PR = 27\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	1.94	4.90	19.74	-3.67	-22.60	4.37	1.53	5.82	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	3.55	7.37	18.73	-5.29	-21.14	5.61	2.58	8.09	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	4.29	8.83	18.38	-6.19	-18.99	7.99	4.12	10.15	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	9.01	13.93	15.17	-7.83	-16.72	8.59	8.17	15.52	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	10.57	15.51	14.68	-8.47	-15.72	9.03	9.76	16.74	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	11.69	16.42	13.47	-8.98	-15.03	9.49	11.51	17.76	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	13.37	17.39	12.79	-9.48	-13.70	9.42	12.76	18.21	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	14.63	17.74	11.86	-9.47	-13.14	10.12	14.87	19.31	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	17.80	19.04	10.56	-9.30	-11.37	10.85	17.95	20.16	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	17.93	19.74	10.46	-9.15	-11.20	10.64	19.33	20.90	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	20.18	19.11	9.10	-9.76	-9.22	9.81	20.04	20.73	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	21.25	20.52	8.64	-9.37	-9.02	10.48	21.53	20.95	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	24.83	19.52	7.17	-9.31	-6.30	9.99	24.94	21.02	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	26.60	20.52	6.71	-8.86	-6.01	10.62	26.59	20.98	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	27.41	21.05	7.16	-8.67	-5.15	10.75	27.59	20.95	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	29.24	21.18	6.53	-9.11	-4.08	10.06	28.10	20.75	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	30.26	20.96	5.53	-8.70	-3.47	9.49	29.08	21.72	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	34.99	19.00	4.21	-5.49	-1.24	10.08	33.98	19.55	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	34.83	18.47	5.33	-8.31	-0.97	9.25	32.56	18.83	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	35.67	17.57	2.92	-5.51	-1.44	9.88	33.96	19.10	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 57. 0.20 mm medium preswirl $PR = 27\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	1.62	5.37	22.69	-4.63	-26.44	4.86	0.98	6.25	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	3.23	8.25	22.04	-6.46	-24.84	7.01	2.08	8.83	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	4.36	10.49	21.24	-7.30	-23.21	8.72	3.93	11.05	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	9.42	14.86	17.43	-10.03	-19.06	10.51	8.75	16.01	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	11.19	16.03	16.39	-10.57	-17.57	11.19	10.56	17.22	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	12.16	16.59	15.00	-10.29	-16.80	11.37	12.02	18.35	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	14.33	17.64	14.27	-11.21	-15.14	11.46	13.67	18.52	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	14.93	17.80	13.13	-10.65	-14.61	11.69	15.20	19.56	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	18.94	19.99	12.61	-11.76	-12.61	12.71	18.65	20.44	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	18.96	19.79	11.57	-11.26	-12.06	12.23	19.59	20.80	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	20.96	18.63	9.81	-11.32	-10.32	11.72	20.62	20.77	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	22.11	21.02	10.25	-11.30	-9.80	12.38	22.55	20.77	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	25.34	19.24	7.65	-10.69	-7.01	11.56	25.85	20.97	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	26.91	20.26	7.16	-10.45	-6.64	12.25	27.55	20.72	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	28.01	20.75	7.49	-10.35	-5.79	11.89	27.98	20.69	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	29.17	20.39	6.97	-10.23	-5.14	11.35	29.09	20.47	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	30.14	19.99	6.23	-10.52	-4.40	10.94	29.61	20.74	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	34.27	18.07	5.62	-7.82	-1.85	11.20	33.40	18.31	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	34.99	17.69	5.51	-9.80	-0.80	9.62	33.41	18.25	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315

Table 58. 0.20 mm medium preswirl $PR = 37\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.85	4.45	15.81	-2.47	-17.63	2.85	4.48	4.70	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	4.68	6.61	15.37	-3.60	-17.10	3.67	5.02	7.02	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	5.65	8.16	14.76	-4.17	-15.83	4.84	6.24	8.43	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	8.78	13.40	13.03	-5.63	-14.14	5.99	9.61	13.85	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	10.46	14.25	11.99	-6.41	-13.51	6.40	10.77	15.41	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	11.59	15.89	11.99	-6.66	-12.51	6.53	11.69	16.18	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	13.09	17.18	11.31	-7.01	-12.23	6.97	13.56	17.44	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	14.14	17.59	10.62	-7.20	-11.38	7.40	14.84	18.16	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	16.95	19.17	9.64	-7.41	-10.53	8.31	17.87	19.66	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	17.78	19.31	8.90	-7.37	-10.03	8.02	19.03	20.03	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	19.19	19.76	8.12	-7.42	-9.02	8.21	19.76	20.19	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	20.56	20.39	7.62	-7.15	-8.70	8.24	20.88	20.94	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	23.47	20.87	7.02	-6.72	-6.85	8.58	24.60	21.45	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	25.98	21.71	6.85	-6.64	-6.36	8.91	26.34	21.74	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	27.09	21.66	6.51	-6.93	-5.85	9.64	27.32	21.88	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	28.30	21.59	6.32	-6.89	-4.73	8.87	27.62	21.80	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	28.95	21.43	6.21	-6.43	-4.38	8.85	29.02	21.77	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	34.27	20.16	6.44	-5.22	-1.48	9.94	33.11	19.89	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	34.91	20.16	5.71	-6.23	-0.94	9.34	33.28	20.47	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	34.90	19.12	2.23	-4.46	-0.16	9.69	34.22	21.13	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 59. 0.20 mm medium preswirl $PR = 37\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.81	4.59	18.18	-3.17	-20.43	3.43	4.18	5.24	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	4.50	6.64	17.42	-4.22	-19.51	4.66	5.22	7.28	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
70	9.20	13.37	14.37	-7.07	-16.00	7.41	9.65	14.29	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	10.90	14.69	13.55	-7.79	-14.93	8.02	11.15	15.43	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	12.04	15.70	12.91	-8.11	-14.11	8.03	12.15	16.56	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	13.40	16.97	12.19	-8.14	-13.32	8.50	13.99	17.37	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	14.38	17.55	11.30	-7.95	-12.64	8.80	15.38	18.38	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	17.77	19.40	10.54	-8.62	-11.44	9.33	18.24	19.25	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	18.28	19.11	9.50	-8.46	-10.79	9.14	19.36	19.91	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	20.15	19.68	9.08	-8.76	-9.70	9.72	20.74	19.77	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	21.34	20.51	8.38	-8.32	-9.22	9.41	21.63	20.48	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	24.48	20.76	7.38	-7.75	-7.14	9.64	25.33	21.09	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	27.07	21.59	7.08	-7.58	-7.01	9.93	26.99	21.66	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	27.70	21.53	6.78	-7.58	-5.88	10.70	27.90	21.40	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	29.18	21.13	6.40	-7.71	-4.86	9.88	28.76	21.22	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	30.09	21.77	5.68	-7.95	-4.13	9.60	28.67	21.77	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	35.05	19.98	5.82	-5.46	-1.53	11.02	34.00	20.00	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	35.33	19.96	6.04	-7.33	-0.49	10.22	33.92	19.88	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	37.00	18.66	2.62	-5.24	-0.90	10.16	34.95	19.96	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 60. 0.20 mm medium preswirl $PR = 37\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.68	4.94	21.05	-4.20	-24.07	4.52	4.67	5.59	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	4.39	7.34	20.43	-5.68	-23.19	5.89	5.36	7.80	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	5.85	8.04	19.31	-6.63	-21.65	6.90	6.95	9.25	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	9.39	13.34	15.84	-8.41	-17.89	9.55	10.88	13.83	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	11.10	14.48	15.08	-9.17	-17.49	9.99	12.19	15.87	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	12.22	15.86	14.42	-9.41	-16.14	10.26	13.33	16.68	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	13.61	16.62	13.15	-9.88	-14.93	10.96	14.91	17.70	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	14.98	17.66	12.73	-9.76	-14.08	11.05	16.52	18.45	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	18.13	19.19	11.62	-9.90	-12.53	11.66	19.61	18.95	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	19.61	18.83	10.25	-10.19	-11.96	11.82	20.75	19.89	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	21.02	20.33	10.27	-10.11	-10.92	11.87	21.95	20.17	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	21.68	20.29	9.22	-9.62	-10.21	11.57	23.23	20.50	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	26.34	20.07	7.65	-9.44	-8.46	12.13	27.05	21.00	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	27.84	20.35	7.46	-9.02	-7.66	12.98	29.17	20.71	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	27.86	20.41	7.44	-8.93	-5.86	12.70	28.83	20.21	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	30.05	20.50	7.03	-9.04	-5.79	11.63	29.96	20.90	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	30.61	20.22	6.47	-8.87	-5.49	11.13	30.07	20.56	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	35.63	18.36	8.03	-6.95	-2.19	11.83	34.78	18.74	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	38.04	18.75	6.63	-8.89	-1.78	10.25	34.81	18.80	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315

Table 61. 0.20 mm medium preswirl $PR = 47\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.94	4.52	14.75	-2.10	-15.80	2.20	4.34	4.48	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	5.67	6.10	14.51	-3.11	-15.03	2.66	4.45	6.27	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	6.36	7.68	13.83	-3.28	-14.62	3.59	5.76	8.04	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	9.35	13.10	12.32	-5.03	-13.38	5.08	9.15	13.34	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	10.23	14.40	11.91	-5.39	-12.52	5.56	9.83	14.66	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	11.65	15.67	11.71	-5.80	-11.98	6.04	10.91	15.94	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	12.44	17.12	11.26	-6.11	-11.46	6.14	12.30	17.14	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	13.53	18.19	10.69	-6.25	-11.13	6.49	13.78	18.39	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	16.53	19.13	9.99	-6.69	-10.11	7.02	16.02	19.86	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	17.77	20.05	9.09	-6.68	-9.82	7.61	17.97	20.43	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	18.84	20.62	8.84	-6.84	-8.99	8.00	19.00	20.54	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	21.18	22.18	8.86	-7.55	-8.11	7.19	19.25	21.18	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	23.41	22.98	7.09	-6.43	-5.36	8.25	24.35	22.80	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	25.40	23.82	7.24	-5.88	-5.45	7.80	25.80	22.58	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	26.74	24.10	7.25	-6.63	-4.90	8.55	26.13	22.81	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	28.63	23.96	6.70	-6.66	-5.03	7.79	27.02	22.87	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	29.25	24.04	6.74	-6.19	-4.22	8.35	28.30	22.76	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	34.99	23.51	6.47	-4.61	-1.62	9.15	33.79	21.54	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	36.08	23.34	5.88	-6.14	-1.49	8.06	32.83	21.58	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	39.26	23.00	2.68	-4.91	-2.58	8.67	34.85	23.06	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 62. 0.20 mm medium preswirl $PR = 47\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.74	4.65	17.11	-2.49	-18.41	2.50	4.70	4.37	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	5.49	6.49	16.50	-3.45	-17.71	3.32	4.93	6.45	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	6.54	7.84	15.98	-4.08	-17.38	4.54	6.04	8.36	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	9.41	13.35	13.82	-6.21	-15.19	6.13	8.93	13.66	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	10.53	14.54	13.04	-6.20	-14.33	6.91	10.60	14.62	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	11.56	16.00	13.03	-6.54	-13.95	6.97	11.49	16.25	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	12.83	17.68	12.72	-7.08	-13.30	7.70	13.14	17.07	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	14.27	19.03	12.17	-7.37	-12.53	7.62	14.21	18.35	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	16.93	19.40	10.79	-7.41	-11.09	8.42	16.89	19.43	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	18.30	20.56	10.42	-7.68	-11.06	8.78	18.39	20.65	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	19.32	21.06	9.48	-7.68	-10.26	8.85	19.46	20.80	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	21.44	21.98	9.29	-7.99	-9.26	9.01	20.76	21.27	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	24.70	22.99	8.25	-7.94	-7.88	8.92	24.72	22.25	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	26.96	23.85	7.91	-7.43	-6.83	8.93	26.01	22.56	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	27.99	23.78	7.51	-7.87	-6.29	9.68	26.82	22.35	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	29.74	24.46	7.42	-7.93	-5.00	9.47	27.73	22.48	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	31.34	25.11	7.17	-7.78	-3.46	8.31	28.74	22.57	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	35.59	24.28	6.35	-4.02	-1.41	10.56	35.37	21.31	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	37.30	24.29	5.97	-5.73	-0.01	8.85	34.62	21.27	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315
330	40.96	21.91	4.21	-6.35	-1.38	8.24	36.39	21.75	0.585	0.578	0.505	0.342	0.464	0.487	0.457	0.373

Table 63. 0.20 mm medium preswirl $PR = 47\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.75	5.21	19.68	-3.12	-21.93	3.30	4.75	4.82	0.054	0.118	0.274	0.096	0.215	0.109	0.110	0.101
30	5.57	6.85	19.08	-4.28	-20.98	4.65	5.10	6.58	0.136	0.153	0.270	0.092	0.230	0.111	0.103	0.111
40	6.92	8.12	18.19	-5.34	-20.12	5.98	6.40	8.46	0.371	0.328	0.196	0.144	0.321	0.276	0.159	0.169
70	10.26	13.45	16.03	-7.32	-17.37	7.95	10.04	13.54	0.172	0.204	0.199	0.210	0.191	0.114	0.137	0.161
80	11.27	14.80	15.32	-7.59	-16.49	8.61	11.22	15.02	0.164	0.186	0.211	0.124	0.101	0.190	0.202	0.143
90	12.42	15.92	14.65	-8.14	-15.57	9.04	12.41	15.93	0.224	0.168	0.167	0.184	0.278	0.122	0.150	0.251
100	13.27	17.14	13.70	-8.34	-14.72	9.24	13.63	17.09	0.210	0.253	0.222	0.164	0.212	0.150	0.188	0.236
110	15.10	18.69	13.45	-9.07	-14.09	9.81	15.24	18.36	0.265	0.202	0.100	0.236	0.165	0.165	0.151	0.255
130	17.91	19.32	11.78	-8.94	-12.78	9.85	17.69	19.55	0.249	0.247	0.211	0.167	0.129	0.226	0.200	0.164
140	19.39	20.48	11.76	-9.21	-11.82	10.32	19.15	19.87	0.244	0.195	0.156	0.225	0.271	0.200	0.227	0.405
150	20.35	21.19	11.01	-9.22	-10.84	10.60	20.48	20.17	0.225	0.207	0.192	0.157	0.199	0.163	0.225	0.234
160	22.31	21.17	10.16	-9.69	-10.31	10.54	21.65	20.88	0.242	0.266	0.241	0.152	0.126	0.222	0.281	0.184
190	25.08	22.35	8.73	-9.41	-8.06	11.18	25.86	21.58	0.243	0.359	0.177	0.077	0.288	0.222	0.266	0.286
200	27.33	22.96	8.67	-9.26	-7.55	11.01	26.97	21.75	0.280	0.243	0.206	0.167	0.165	0.211	0.358	0.276
210	28.40	23.20	8.30	-9.37	-6.74	10.92	27.91	21.62	0.303	0.303	0.147	0.158	0.173	0.187	0.248	0.208
220	29.99	22.99	7.69	-9.20	-5.86	10.64	28.63	21.68	0.375	0.461	0.270	0.285	0.155	0.332	0.220	0.265
230	31.08	22.67	7.29	-9.27	-5.49	10.17	29.80	21.82	0.513	0.415	0.206	0.302	0.321	0.142	0.308	0.275
280	36.26	21.07	6.94	-7.02	-2.08	11.37	34.64	19.66	0.612	0.500	0.491	0.582	0.339	0.322	0.624	0.324
290	37.75	21.63	6.27	-8.33	-1.72	10.12	34.13	19.66	0.540	0.380	0.197	0.395	0.381	0.323	0.328	0.315

Table 64. 0.20 mm zero preswirl $PR = 17\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.16	5.80	10.54	-2.34	-11.60	2.00	-0.09	5.67	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	-0.10	8.38	9.96	-3.16	-11.18	2.96	1.12	8.44	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	1.14	10.32	9.38	-3.75	-10.61	3.95	2.49	10.44	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	5.85	15.81	7.94	-5.00	-8.36	5.19	6.81	15.00	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	7.01	16.74	7.32	-5.31	-7.65	5.21	7.87	16.24	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	8.48	18.39	6.89	-5.31	-6.96	5.57	9.53	17.44	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	9.76	19.78	6.44	-5.71	-6.76	5.01	11.00	18.50	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	12.25	20.35	5.94	-5.90	-6.39	5.03	12.53	19.69	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	15.23	20.31	4.84	-6.01	-5.61	4.76	15.43	20.92	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	16.23	21.99	4.82	-6.06	-4.96	5.26	16.79	20.74	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	17.30	22.52	4.93	-6.25	-4.55	4.82	17.82	20.50	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	18.14	22.16	3.26	-6.45	-4.42	5.85	19.08	22.10	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	21.46	22.81	3.82	-6.06	-4.20	6.00	22.82	21.51	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	24.20	22.78	3.19	-6.80	-3.76	6.10	23.66	21.54	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	24.26	22.58	2.70	-6.20	-3.17	6.00	24.48	22.25	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	26.11	23.02	2.29	-6.24	-3.21	5.58	25.71	22.42	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	27.24	22.84	1.90	-6.28	-3.32	5.36	26.80	22.47	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	32.26	20.08	1.16	-3.68	-1.41	7.82	30.66	20.29	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	32.13	19.88	1.36	-5.26	-1.77	7.14	31.92	20.92	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301

Table 65. 0.20 mm zero preswirl $PR = 17\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-1.33	6.50	14.61	-3.30	-16.04	2.98	0.20	5.99	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	0.17	9.04	13.85	-4.61	-15.11	4.26	1.58	8.62	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	0.94	9.78	12.58	-5.26	-13.34	5.81	3.00	10.55	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	6.59	15.84	9.99	-7.38	-11.33	6.69	7.06	15.55	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	7.62	17.21	9.54	-7.24	-10.34	7.45	9.12	16.63	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	9.09	18.86	9.27	-7.58	-9.28	7.01	10.46	17.78	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	10.75	19.96	8.36	-7.78	-9.12	6.95	12.16	18.43	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	12.66	20.47	7.88	-7.69	-8.46	7.07	13.52	19.53	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	15.67	20.31	6.07	-7.97	-6.76	7.34	16.72	20.17	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	16.84	21.64	5.95	-7.52	-6.98	7.17	17.59	20.97	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	17.77	21.92	5.77	-7.61	-6.19	7.31	18.94	20.68	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	19.91	21.98	5.03	-7.95	-6.09	6.95	20.38	21.13	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	22.88	22.87	4.03	-7.47	-5.27	7.13	23.92	21.29	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	25.14	22.54	3.61	-7.70	-4.90	6.83	24.48	21.34	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	25.20	22.31	3.19	-7.54	-3.95	7.24	25.48	21.69	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	26.96	23.26	2.63	-7.72	-3.89	6.26	25.98	21.87	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	28.88	23.42	2.28	-8.16	-3.30	5.83	27.38	22.32	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	33.27	20.83	-0.60	-2.21	-1.47	7.47	33.98	20.91	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	33.35	20.41	1.46	-5.48	-2.08	7.86	32.91	20.17	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	33.10	18.57	0.32	-4.83	-0.37	7.70	35.27	16.78	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 66. 0.20 mm zero preswirl $PR = 17\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	-2.11	7.00	19.88	-4.36	-21.28	4.31	-1.41	6.58	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	-0.66	9.99	18.72	-5.69	-19.93	6.04	0.11	9.26	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	1.32	12.38	17.41	-7.49	-18.95	7.41	1.63	11.63	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	7.35	17.77	14.44	-9.86	-15.63	9.19	6.95	17.22	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	8.52	18.33	12.99	-9.89	-13.91	10.20	8.97	18.04	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	10.46	19.56	11.63	-10.43	-12.74	9.72	10.61	19.10	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	11.70	20.69	10.80	-9.89	-12.20	9.30	11.91	19.82	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	14.35	21.11	9.90	-10.91	-11.79	10.09	14.00	20.92	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	17.11	20.79	8.14	-10.00	-9.78	10.14	17.07	21.44	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	19.05	22.28	8.12	-10.96	-9.51	10.11	18.40	21.92	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	19.30	23.02	7.58	-10.33	-8.74	10.19	19.63	21.68	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	21.06	22.34	6.81	-9.99	-7.51	9.48	20.73	21.75	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	24.15	22.85	5.38	-9.76	-7.96	10.31	24.41	22.24	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	26.33	22.20	4.59	-9.59	-6.34	9.72	25.25	21.77	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	26.90	21.77	4.52	-9.55	-5.48	9.79	26.24	22.30	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	28.37	21.65	3.82	-9.61	-5.07	9.19	27.38	21.98	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	29.22	21.83	3.64	-9.09	-5.12	8.96	28.82	22.63	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	34.08	19.59	2.76	-6.91	-2.71	10.07	33.17	19.12	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	34.63	18.61	2.82	-8.42	-3.21	9.91	33.41	20.18	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301

Table 67. 0.20 mm zero preswirl $PR = 27\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	1.04	5.30	9.94	-2.01	-11.27	1.87	1.50	5.48	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	1.80	7.68	9.73	-2.80	-10.74	2.67	2.51	7.76	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	2.81	9.68	9.14	-3.23	-10.16	3.45	3.72	9.53	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	6.73	14.80	7.86	-4.66	-8.43	4.60	7.56	14.74	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	8.16	16.06	7.24	-5.15	-7.88	4.89	8.98	16.15	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	9.63	17.77	7.14	-5.46	-6.80	4.74	10.12	17.05	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	11.48	19.15	6.49	-5.97	-6.53	4.80	11.81	18.42	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	12.97	19.58	5.95	-5.68	-6.56	5.11	13.61	18.95	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	15.83	20.36	4.83	-6.01	-5.96	4.88	15.40	20.79	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	17.09	21.02	5.06	-5.61	-5.90	5.11	18.00	20.52	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	18.76	20.80	4.54	-5.85	-5.37	5.16	19.45	20.82	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	20.68	22.70	4.39	-7.30	-3.96	4.44	18.77	21.55	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	22.94	23.07	3.82	-5.58	-3.64	5.46	24.18	21.69	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	25.01	23.33	3.64	-6.07	-3.70	5.46	24.36	21.72	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	25.80	22.75	3.23	-6.52	-2.74	5.18	25.46	21.86	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	27.35	22.75	2.62	-6.77	-3.57	5.51	26.65	22.29	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	28.18	22.09	2.39	-6.34	-3.78	6.14	27.75	22.43	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	33.46	20.61	0.62	-4.87	-1.57	7.34	32.41	20.70	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	34.34	19.68	1.24	-5.52	-2.88	7.44	33.23	20.89	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	34.54	17.71	-0.95	-3.99	1.03	8.32	37.00	17.61	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 68. 0.20 mm zero preswirl $PR = 27\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	0.97	5.97	14.14	-2.93	-15.58	2.70	1.60	5.78	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	1.88	8.04	13.30	-4.02	-14.77	3.92	2.61	7.95	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	2.25	8.85	12.37	-4.47	-12.69	5.93	3.95	9.83	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	7.26	15.12	10.28	-6.58	-11.29	6.21	8.00	15.01	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	8.47	16.36	9.43	-6.61	-10.38	7.01	9.98	16.18	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	10.10	18.19	9.50	-7.04	-9.24	6.52	11.01	17.42	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	11.93	19.23	8.71	-7.84	-9.02	6.45	12.39	18.58	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	13.37	20.09	8.12	-7.34	-8.90	7.00	14.31	19.54	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	16.56	20.68	7.15	-7.81	-7.75	6.87	17.27	20.71	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	17.63	21.05	6.32	-7.20	-7.32	6.92	18.25	20.39	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	18.85	22.01	6.30	-7.31	-6.77	6.53	19.41	20.86	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	20.38	21.75	5.76	-7.99	-6.37	6.86	20.84	21.64	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	24.14	22.87	4.76	-7.91	-5.18	6.38	24.44	21.50	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	26.24	23.03	4.62	-8.30	-5.08	6.61	25.77	21.55	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	26.55	22.12	3.43	-8.18	-4.40	6.54	26.25	22.02	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	28.28	23.44	2.62	-8.07	-3.88	6.51	27.00	22.53	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	29.73	23.67	2.93	-9.07	-2.91	5.98	27.53	22.04	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	34.57	22.09	-1.13	-2.61	-1.09	7.79	35.57	21.74	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	35.28	21.05	0.94	-5.78	-1.61	7.34	34.86	20.36	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	36.95	16.79	1.05	-5.82	-0.31	7.29	37.73	16.22	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 69. 0.20 mm zero preswirl $PR = 27\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	0.21	7.30	19.85	-3.98	-21.24	3.32	-0.14	5.96	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	1.32	9.20	18.39	-5.87	-20.25	5.56	1.17	8.97	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	2.11	10.87	16.95	-6.15	-18.62	7.12	2.82	11.14	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	7.08	15.77	13.14	-8.93	-15.16	8.92	7.92	16.43	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	8.63	17.27	12.45	-9.04	-13.62	9.77	9.83	17.28	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	10.28	18.83	12.19	-9.41	-12.59	9.63	11.40	18.46	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	12.10	19.82	10.78	-10.30	-11.80	9.89	13.11	19.16	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	13.65	21.09	10.77	-9.68	-11.05	9.93	14.73	19.87	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	17.30	21.51	9.38	-10.32	-9.69	9.71	17.16	21.14	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	18.19	21.79	8.83	-9.39	-9.01	9.97	19.08	21.14	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	18.88	22.02	8.15	-9.27	-8.02	9.74	20.31	21.33	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	21.36	22.02	7.70	-10.65	-7.41	9.80	21.73	21.64	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	24.30	21.72	5.71	-10.52	-6.22	9.48	25.12	21.72	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	26.78	22.52	5.08	-10.98	-6.08	9.00	25.63	21.68	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	26.93	21.96	4.60	-10.12	-5.11	9.31	27.18	21.91	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	28.56	22.23	4.20	-9.72	-5.46	9.00	28.39	22.29	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	29.64	21.55	3.31	-10.10	-5.31	9.07	29.68	22.33	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	34.57	19.57	2.33	-6.97	-2.77	9.81	33.91	19.72	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	35.68	18.79	1.96	-8.49	-2.79	9.62	35.00	20.31	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301

Table 70. 0.20 mm zero preswirl $PR = 37\%$ $\omega = 10{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.70	4.57	9.09	-1.60	-10.13	1.65	4.00	4.72	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	4.24	6.62	8.91	-2.18	-9.70	2.31	4.62	6.66	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	5.24	8.24	8.66	-2.62	-9.14	2.82	5.31	8.24	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	8.62	13.40	7.04	-4.08	-7.61	3.25	8.62	13.68	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	8.81	15.07	7.11	-4.41	-7.30	3.78	9.81	15.01	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	10.49	16.84	6.96	-5.06	-6.91	4.18	10.97	16.16	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	11.99	18.29	6.23	-5.27	-6.53	3.99	12.35	17.66	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	13.57	18.86	5.94	-5.11	-6.30	4.30	13.74	18.89	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	16.68	19.64	4.47	-5.09	-5.70	4.73	17.53	19.72	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	17.59	20.40	4.80	-5.75	-5.62	4.40	17.46	20.00	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	19.37	20.49	4.07	-5.68	-5.13	5.10	18.81	20.57	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	20.81	21.58	2.51	-5.48	-5.13	4.10	20.01	22.18	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	23.69	23.04	4.31	-5.41	-3.60	4.98	23.92	21.27	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	25.89	23.54	3.64	-6.14	-3.83	5.25	24.39	21.59	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	26.04	22.84	2.58	-5.44	-2.84	5.35	25.44	22.55	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	27.17	23.06	2.41	-5.29	-4.07	5.67	26.81	22.95	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	27.98	23.23	2.86	-5.63	-3.49	6.42	27.62	22.87	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	33.84	21.28	0.92	-4.15	-1.60	8.48	33.12	21.42	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	34.20	20.71	1.65	-5.27	-2.18	8.36	33.47	21.92	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	34.23	18.36	-0.93	-4.81	3.12	11.82	38.92	20.60	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 71. 0.20 mm zero preswirl $PR = 37\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	3.49	4.98	12.70	-2.30	-14.05	2.39	4.45	4.79	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	4.34	6.82	12.16	-3.30	-13.60	3.30	5.10	6.93	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
70	8.71	14.21	10.07	-5.66	-10.55	5.48	9.35	13.70	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	9.61	15.31	9.29	-6.00	-10.03	5.75	10.63	15.09	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	10.86	17.14	9.25	-6.21	-8.87	6.00	11.90	16.20	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	12.65	18.69	8.47	-6.98	-8.56	5.63	13.24	17.30	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	14.38	19.42	7.98	-6.97	-8.34	6.25	14.76	18.18	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	17.21	19.76	6.24	-7.12	-7.61	6.30	17.43	19.86	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	18.38	20.81	6.42	-6.81	-7.01	6.52	19.01	19.63	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	19.62	21.13	5.78	-6.66	-6.12	6.28	20.04	20.12	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	21.79	21.50	4.94	-7.55	-6.62	6.57	20.80	20.84	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	24.10	22.68	4.74	-7.33	-5.24	7.26	24.60	21.20	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	26.44	23.34	4.38	-7.63	-5.26	7.09	25.49	22.09	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	26.52	22.42	3.53	-6.81	-4.07	7.44	26.38	21.92	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	28.55	23.99	3.72	-6.84	-3.66	6.70	27.50	22.01	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	29.71	23.54	2.67	-7.28	-3.85	6.78	27.96	23.16	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	36.62	21.35	-1.56	-5.73	-2.09	9.00	33.13	23.25	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	36.02	20.21	2.28	-6.81	-2.65	9.32	33.87	21.61	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	37.01	18.98	0.25	-5.09	0.42	11.46	38.72	19.57	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 72. 0.20 mm zero preswirl $PR = 37\%$ $\omega = 20{,}200 RPM$

Test Data									Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	2.78	5.67	18.02	-3.33	-19.68	3.43	2.93	5.44	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	3.51	7.66	17.07	-5.04	-19.00	4.81	3.80	7.72	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	4.87	8.80	16.16	-5.90	-17.78	5.81	4.95	9.75	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	8.80	14.94	13.20	-7.80	-14.90	8.17	9.51	15.12	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	10.14	16.54	12.57	-8.38	-13.45	9.03	10.93	16.30	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	11.50	18.12	11.89	-8.91	-12.63	8.69	12.04	17.56	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	13.50	19.57	11.23	-9.55	-11.97	9.44	14.22	18.65	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	14.97	20.70	10.95	-9.24	-11.11	9.41	15.52	19.60	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	18.41	21.16	9.14	-9.75	-9.80	9.05	18.35	20.31	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	19.27	21.67	8.61	-8.89	-9.21	9.52	20.04	20.84	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	20.06	22.20	8.26	-8.94	-8.73	9.38	20.97	21.12	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	22.38	22.52	7.77	-9.99	-7.90	9.15	22.33	21.80	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	25.47	23.20	6.07	-9.51	-7.37	9.76	26.08	22.18	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	28.11	23.48	5.65	-10.06	-6.74	9.08	26.74	22.48	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	28.11	22.90	4.89	-9.39	-5.60	9.60	27.64	22.52	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	30.14	23.32	4.66	-9.38	-5.59	9.41	28.88	22.59	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	30.81	23.13	4.45	-9.36	-5.51	9.62	30.12	22.61	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	37.19	20.81	2.66	-7.27	-2.78	11.17	34.57	20.86	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	37.31	19.74	2.67	-8.95	-3.21	10.93	35.52	21.11	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301

Table 73. 0.20 mm zero preswirl $PR = 47\%$ $\omega = 10{,}200 RPM$

Test Data									Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.12	4.00	8.50	-1.33	-8.95	1.36	4.71	4.05	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	5.53	5.80	8.31	-1.75	-8.63	2.11	5.18	6.00	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	6.38	7.54	8.43	-1.85	-8.51	2.36	6.43	8.19	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	8.88	12.69	7.35	-3.54	-7.47	3.34	8.88	12.84	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	9.37	14.34	7.12	-4.00	-6.96	3.66	9.82	14.21	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	10.90	16.07	6.85	-4.41	-6.25	3.56	10.71	15.84	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	12.04	17.33	6.40	-4.38	-6.30	3.63	12.59	16.77	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	13.74	18.19	5.96	-5.13	-6.09	3.88	14.13	18.55	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	16.15	19.15	5.32	-4.49	-5.63	4.00	16.52	19.13	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	17.92	19.74	5.14	-5.96	-5.88	4.08	17.22	20.37	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	19.24	19.68	4.62	-5.56	-5.51	5.07	18.93	21.12	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	20.84	20.80	5.11	-3.89	-5.20	4.16	22.10	20.50	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	23.63	22.52	4.29	-6.14	-4.15	4.80	23.51	21.96	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	25.60	24.06	3.82	-6.78	-3.82	4.27	24.14	22.00	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	26.46	22.97	3.28	-6.28	-3.49	5.07	25.77	23.23	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	27.26	22.87	3.15	-5.89	-4.11	5.25	27.57	23.20	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	28.58	23.32	2.64	-6.05	-3.45	5.96	28.12	23.50	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	34.44	21.99	1.31	-4.00	-1.90	7.43	33.56	21.80	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	34.68	21.36	1.69	-5.58	-2.37	7.43	33.73	22.45	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	36.64	21.34	-0.65	-4.20	1.48	8.25	40.04	19.80	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 74. 0.20 mm zero preswirl $PR = 47\%$ $\omega = 15{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	5.08	4.09	12.30	-1.81	-12.79	2.17	5.87	4.44	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	5.71	6.21	11.75	-2.90	-12.13	2.79	6.02	6.17	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	6.72	7.84	11.72	-3.31	-12.03	3.63	6.81	7.86	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	9.25	13.17	9.93	-4.80	-10.07	4.89	9.79	13.44	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	10.31	14.47	9.36	-5.46	-9.37	5.61	11.30	14.67	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	11.55	16.29	9.26	-5.54	-8.54	5.04	11.94	15.85	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	13.01	17.52	8.45	-6.27	-8.52	4.65	13.41	17.11	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	14.64	18.58	8.31	-6.59	-7.90	5.28	14.77	17.93	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	18.15	19.34	7.28	-6.78	-7.02	5.80	17.70	18.86	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	18.23	20.44	6.90	-6.79	-7.17	5.83	19.10	19.67	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	19.71	20.32	6.35	-6.70	-6.60	5.04	20.31	20.05	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	21.56	21.21	6.18	-6.90	-6.10	6.02	21.64	20.88	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	24.79	22.54	5.35	-7.74	-5.59	5.68	25.36	21.82	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	26.71	23.69	4.67	-7.76	-5.29	5.89	26.16	21.81	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	28.09	23.09	4.35	-7.73	-4.46	6.01	26.93	22.20	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	29.44	23.51	3.67	-7.62	-3.98	6.08	28.23	22.28	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	30.81	23.25	2.92	-7.62	-3.21	6.14	29.16	23.13	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	36.39	21.31	0.83	-3.42	-3.04	8.17	35.33	22.56	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	36.62	21.42	1.53	-6.80	-1.56	8.35	35.36	21.85	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301
330	38.50	19.22	-0.03	-6.19	-0.18	8.24	40.13	19.24	0.840	0.441	0.259	0.299	0.483	0.788	0.501	0.536

Table 75. 0.20 mm zero preswirl $PR = 47\%$ $\omega = 20{,}200 RPM$

	Test Data								Uncertainties							
f	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}	Rz_{xx}	Iz_{xx}	Rz_{xy}	Iz_{xy}	Rz_{yx}	Iz_{yx}	Rz_{yy}	Iz_{yy}
20	4.19	4.87	16.98	-2.96	-17.56	2.49	4.51	4.71	0.133	0.147	0.199	0.167	0.174	0.169	0.199	0.116
30	4.99	6.93	16.35	-4.33	-16.90	3.99	4.91	6.74	0.094	0.120	0.210	0.101	0.149	0.129	0.156	0.124
40	6.17	8.62	15.60	-5.00	-15.99	5.07	5.90	8.65	0.369	0.344	0.220	0.111	0.309	0.290	0.179	0.135
70	9.47	14.15	13.51	-6.91	-14.09	6.82	10.10	14.12	0.158	0.151	0.129	0.247	0.204	0.194	0.282	0.241
80	10.30	15.69	12.79	-7.27	-13.18	7.60	11.51	15.56	0.139	0.184	0.164	0.147	0.146	0.154	0.223	0.204
90	11.73	16.89	12.18	-7.77	-12.16	7.59	12.42	16.55	0.144	0.255	0.209	0.118	0.192	0.146	0.167	0.259
100	13.50	18.59	11.12	-8.64	-11.42	7.81	13.74	17.91	0.209	0.236	0.189	0.137	0.195	0.179	0.201	0.259
110	15.16	19.34	10.62	-8.78	-10.92	8.27	15.28	18.62	0.145	0.267	0.200	0.114	0.168	0.151	0.223	0.308
130	18.65	20.36	9.95	-9.12	-9.65	8.17	18.43	19.63	0.307	0.234	0.155	0.314	0.164	0.136	0.237	0.259
140	19.19	21.23	9.43	-8.99	-9.58	8.52	19.51	20.35	0.267	0.268	0.153	0.121	0.235	0.227	0.212	0.253
150	19.97	20.89	8.40	-8.91	-8.42	8.22	20.71	20.44	0.343	0.327	0.209	0.178	0.214	0.304	0.159	0.241
160	22.12	21.56	8.22	-9.54	-8.23	8.82	22.09	21.46	0.214	0.265	0.151	0.190	0.232	0.157	0.328	0.302
190	25.38	22.55	6.56	-10.36	-7.12	10.04	26.25	21.84	0.295	0.489	0.142	0.189	0.285	0.326	0.305	0.322
200	28.04	23.45	5.93	-10.53	-6.54	9.47	27.05	21.60	0.386	0.367	0.199	0.235	0.261	0.296	0.325	0.285
210	28.58	22.87	5.19	-10.18	-5.65	9.39	27.90	22.13	0.297	0.371	0.123	0.201	0.163	0.257	0.242	0.297
220	30.05	23.14	4.72	-9.99	-5.72	8.95	28.94	22.24	0.340	0.218	0.209	0.192	0.289	0.163	0.223	0.252
230	31.03	22.76	4.44	-9.82	-6.01	9.84	30.99	22.65	0.370	0.341	0.161	0.325	0.293	0.172	0.347	0.284
280	36.87	20.75	2.58	-7.80	-3.07	11.41	33.81	21.01	0.458	0.309	0.235	0.492	0.332	0.264	0.417	0.287
290	37.79	20.51	2.72	-8.76	-3.52	11.10	36.15	21.64	0.295	0.306	0.245	0.243	0.295	0.339	0.277	0.301

VITA

Jonathan Leigh Wade was born on December 27, 1979 in Tyler, Texas, where he lived until moving off to college. In the fall of 1999 he moved to College Station, Texas, to attend Texas A&M University. He graduated in May of 2002 with a Bachelor of Science degree in Mechanical Engineering. He is currently completing the requirements to receive a Masters of Science degree from Texas A&M University in May of 2004. He can be reached at the following permanent address:

Jonathan Leigh Wade
15157 FM 2015
Tyler, TX 75706